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Livestock Feeds and Feeding in Latin America

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FORWARD

This report is designed to summarize the overall status of livestock production in Latin America and to present an approach for animal agricultural development for less developed countries. The approach presented is the so-called "total package" concept where all the limitating factors to production improvement are dealt with simultaneously and with equal emphasis.

When reading the report, emphasis should be focused on section III, Production Principles (Universally Applicable). The main thrust of the report is contained in this section. The other sections of the report are not de-emphasized, however.

The paper draws attention to the present status as well as the development potential of Latin American livestock production. Grasslands and their production of forages and forage utilization by beef cattle have received special attention. The report is outlined and written so that each section can be referred to separately giving concepts and ideas without studying the entire document. The report will serve as a guide for planning and implementing livestock production development projects in developing countries.

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I. Introduction and Scope of the Problem

The livestock industries have traditionally been part of Latin American agriculture since colonial times. In relatively few countries, however, have livestock been of major importance to the national economy. In recent years expansion in livestock production has been considered as a desirable goal in economic development. Increased emphasis on livestock industry improvement, particularly beef cattle, has led to considerable financial assistance and large development programs in many Latin American countries.

Meat production increased gradually in most Latin American countries during the past decade, but has not quite kept pace with population growth. Pork production grew less than population and per capita consumption declined in nearly all countries. Production of lamb and mutton increased about the same as population (Florida, 1970 and U. S. D. A., FLM 1 and 4-69, 4-70, 1-71). Beef represents the largest share of Latin American meat production and utilization. Total beef production increased slowly during the 1960's providing growth in per capita consumption and exports in only a few countries. With growth in consumer incomes, some countries were able to import beef and other meats, mainly from other Latin American countries.

Livestock and meat trade between the U. S. and Latin America grew substantially during the past decade (Florida, 1970 and U. S. D. A., FLM 9-70, 11-70). Most countries in the region increased their imports of breeding stock of all species from the U. S. The United States also became an important supplier of processed meats to the Caribbean countries and a large shipper of by-products to a number of Latin American countries. A large proportion of Central American beef

exports went to the U. S. as well as a number of feeder cattle from Mexico (Rourk, 1969). Argentina, Brazil, Uruguay and Paraguay continued their export of processed beef to the U. S.

The justification for expending funds on increased animal production in the developing countries of the tropics is often a laborious process, since many people feel that these products are obsolete and inefficient. However, the fact is that animal products provide a significant, extremely desirable portion of the human diet. Although plant products can be fortified to fill the major nutritional needs of the human, there are psychological and sociological needs for products from domesticated and wild animals.

The strongest justification for continued and increased investments in teaching, research and extension in animal production is utilization of otherwise unproductive land and inedible by-products by livestock to produce a highly nutritious and palatable food. This established fact is particularly applicable in the tropical areas of the world, where large amounts of land reach their economical and ecological climax in the production of forages for livestock production. Other land in remote or newly developing areas should pass through a stage of use for pasture and livestock production to allow its use for production of crops for human consumption. Lands which are more suitable for crop production make available large quantities of by-products which may become environmental pollutants if not utilized by livestock.

This being so, we should now proceed from the point of arguing the desirability of increasing livestock production capability to an analysis of the present status and future potential of such production.

There is a danger of generalizing when one attempts to classify

the critical areas which affect and limit livestock production. Generally accepted limitations are 1) sociologic; 2) biologic; and 3) economic. These factors are interwoven in such a way that significant advances in production cannot be achieved by seeking to improve or resolve only one or two of these factors. Therefore, the fact that they are discussed separately does not indicate that they can be resolved the same way.

1) Sociologically, livestock production, particularly beef cattle production, is considered as a questionable enterprise. In the Latin American tropics, many ranchers have inherited their lands and cattle, often without having lived or worked on the land. Generally these individuals have other sources of income thus do not depend on cattle for his livelyhood. As a result, their prime concern is seldom one of productivity levels and efficiency of operation and therefore, results in low animal production per unit of land.

The majority of these cattlemen do not reside on their land which hinders increased productivity. Instead they seek the security of urban residence, where they can take advantage of the benefits offered by a city. The isolation of farm residence limits, to a great extent, one's social contacts which form an important part of a person's life. However, this leaves the management of the land in the hands of a manager, whose main concern are not productivity and efficiency.

The manager, often is an excellent cow handler but due to his lack of education and contact with improved systems of production, simply follows the historically accepted management practices. Because of the isolated location of most of the ranches it is difficult to retain a veterinarian, agronomist or animal husbandman for permanent employment.

Opening areas by building of roads reduces isolation but, still, distances to the cities are long. Improved transportation increases the probability of these lands being used for crop production, causing the livestock producing area to be moved to new, more isolated locations.

2) The biological factors which limit livestock production in the tropics at present have been well described in a number of publications and speeches. These can be divided into two areas: a) problems for which solutions are known but not applied and b) problems for which solutions have not yet been found. If we delay the discussion of the effects of economic considerations on application of known solutions, the solution of both types of problems can be divided between education, research and extension.

It is generally accepted that new emphasis is needed in education to bring about improvements in livestock production. These reforms should be directed toward higher education, secondary and primary education, to insure the preparation of agricultural workers at all levels.

Research needs for livestock production in the tropics have also been discussed with agreement that applied research with immediate application should precede more basic research in order to solve the present needs of producers and to win their confidence and support later for basic research. Under present conditions with the limited human and financial resources available, priorities must be agreed upon and followed. The priorities of research programs are given later in this report. Methods must be developed to increase the number of and improve the education and support of research workers.

Very little emphasis has been placed on extension programs in Latin America and other developing areas. Negligible financial support is available for the development of such programs. Few people are

available in Latin America with the necessary experience to develop and carry out extension programs. Sufficient data are available from the tropical and sub-tropical areas of developing and developed areas of the world to substantially increase the existing production levels in Latin America if the knowledge was applied. Techniques to persuade farmers to apply new methods need to be developed and utilized. Increased production resulting from more efficient, effective extension may increase political and economic support for education and research.

3) In Latin America economic factors impede increases in production levels and limit the resolving of many sociological and biological problems. The low purchasing power of the public reduces the demand for quality and quantity of livestock products. Increased costs of imports, fertilizers, machinery, fencing, etc. reduce their economic benefits to the livestock industry.

The opening of export markets can reduce the effect of these limiting economic factors. The highest prices for exported meat results in more profit to the producer and allow the lower market quality meat to be sold locally at reduced prices. The population is better fed by the increased local consumption. The growth of local and export industries expands as production efficiency and marketing potential increases breaking the vicious cycle of low demand-low efficiency.

II. Latin American Livestock Industry

The livestock industry is important to all areas of the world. There are three reasons which make this industry particularly important to Latin America: 1) reduce malnutrition, 2) increase foreign exchange earnings and 3) utilize available land masses suited to livestock production. The majority of Latin America's people do not receive sufficient protein in their diet. The average daily protein intake for most people in Latin America is 30 to 35 grams per day as compared to 95 grams per day in the U. S. (Phillips, 1969). Most Latin countries have an unbalanced import-export status which creates economic stress (Christiansen, 1965). Improved livestock production has contributed greatly to the economic conditions of several countries. Examples are Argentina, Nicaragua, Guatemala and Mexico. Most Latin American countries, particularly under tropical conditions, have tremendous potential for increasing the amount of marketable livestock products (Christiansen, 1964). The climate, potential soil productivity and topographic conditions in Latin countries favor development of the lands for livestock production.

A. Current Status

This section briefly describes the status of several aspects of the Latin American livestock industry. The purpose of stating the existing conditions is to establish a basis for comparison. Production potential and ways of improving production are presented and compared later in this report.

1. Livestock

a. Production Levels

(1) Parturition Percentage

Although considerable variation exists in Latin America evidence suggests that 40 to 50 is near the actual parturition percentage for beef cattle (Christiansen, 1964; Rourk, 1969; Cox, 1966; and Warnick, 1971). The parturition percentage in the U. S. is 85 to 90 percent. Argentina and Uruguay have higher parturition percents while Bolivia, El Salvador, Honduras and Peru have under the 50 percent level (Christiansen, 1965 and Rourk, 1969).

(2) Mortality Rate

Most evidence indicates that the mortality rate for beef cattle in Latin America is about 12 to 15 percent (Rourk, 1969 and Shackford, 1970). The comparable figure for the U. S. is 5 to 6 percent. The major factor contributing to mortality is believed to be disease. There is a growing opinion that most diseases arise from poor nutritional and management conditions.

(3) Age and Weight at Marketing

Marketing weight of beef cattle in Latin America varies from 250 to 500 kilograms (Rourk, 1969; Cox, 1966 and Christiansen, 1965). An average for Latin countries is about 340 kilograms (748 lbs.). The market weights are generally higher than the average for areas where progressive production methods are practiced and lower for areas applying primative conditions. Beef animals in the U. S. are usually marketed between 18 to 20 months of age at an average weight of 500 to 550 kilograms per animal. Market age of beef cattle

varies from 2 to 6 years in Latin America (Rourk, 1969; Christiansen, 1964; Phillips, 1956). Market weight does not always increase as market age increases. For example, in parts of El Salvador, Honduras, Panama, Bolivia and Brazil a market age of 5 years is common with the average market weight being below 340 kilograms. In areas where progressive production conditions exist such as parts of Argentina, Uruguay, Brazil, Nicaragua, Guatemala and Mexico steers are commonly marketed at about 2 1/2 to 3 years of age with a market weight in excess of 400 kilograms per animal.

(4) Female Life-time Productivity

As used in this report, female life-time productivity reflects the number of offspring and total weight of offspring at weaning time, for the entire life of the female. In Latin countries it is common for heifers to calve first at 3 or 4 years of age and be culled at 8 to 9 years of age. Every other year calving is also common which is, in line with less than 40 to 50 percent parturition (Christiansen, 1964). In Latin America, the number of calves per cow-life is three or less compared to 6 to 8 calves per cow-life in the U. S. Typical weaning weights of 150 kilograms (a generous figure) would indicate that the average cow-life productivity would be about 400 to 450 kilograms calf weight in Latin America. In the U. S. cow-life productivity of 1200 kilograms are common with average weaning weights of 200 kilograms per calf.

b. Breeds and Breeding Practices

(1) Breeds

There is a wide variation of breeds and types of livestock in Latin America. In temperate climate zones the major breeds of cattle are Hereford, Angus and Shorthorn. Charolais, Brahman and other new breeds are being introduced into these areas. Native or Criollo type cattle are produced in all areas. In tropical countries the Criollo has little or no Bos indicus breeding and, although they are decreasing rapidly numbers and percentages, are still a significant factor in beef and milk production. In tropical and subtropical regions the major improved breed is of Brahman type. The introduction of Bos indicus breeding has been beneficial in improving cattle. The Brahman has generally been most important because of selection and ease of availability.

Good quality beef cattle can be found in nearly all regions of Latin America and are becoming more widespread. At the present time several reports and observations indicate that management and nutrition are the sources of more serious limitation on production as compared to those derived from breeds of livestock available in Latin America.

(2) Breeding Practices

Within the scope of breeding practices, methods of improving livestock production through performance and pregnancy testing, bull grading, artificial insemination and estrous control need to receive attention in Latin America. Presently, less than 5 to 10 percent of the livestock in Latin America are produced under any organized program using improved breeding systems (Cox, 1966 and Christiansen, 1965).

Proven methods must be adopted on a larger scale if Latin America livestock is to be improved by an appreciable amount.

c. Quality Standards

Livestock and meat standards should not be considered in any way comparable with those common to the U. S. First, livestock diets in most of Latin America place an important limit on quality aspects of livestock products. Second, the major markets for Latin American livestock products are different from those of the U. S.

(1) Grades

The majority of beef produced in Latin America would be classed in lower quality grades, low good and standard based upon the U. S. standards. These lower grades may be due to older age and a lesser degree of finish (fat to lean ratio).

(2) Facilities (slaughter and storage)

The number of modern and adequate slaughter facilities is closely related to the market of the product. The market is defined by the consumer's ability to pay and desire for a given quality of meat product. In many areas modern facilities are not utilized because of marketing structure and desire of local consumers to purchase meats on the same day the animal is slaughtered. The poverty consumer market has limited quality and sanitation standards. European export markets require that meat be processed under higher standards than those of the local markets. Meats exported to the U. S. must be processed with high standards under certified conditions.

(3) Sanitation

Sanitation conditions depend on the facilities available, laws and their systematic enforcement by trained personnel. The degree of utilization of the facilities and enforcement of laws to maintain sanitary processing conditions is determined by the economic and educational levels of the consuming public. One important exception is under rural poverty conditions, where the low volume of livestock slaughtered, and the low concentration of inhabitants are often conducive to relatively sanitary slaughter conditions. Examples are the so-called under-the-tree or shed type slaughter facilities.

2. Livestock Feeds

a. Forage and Other Roughages

Forage production on open range, fenced permanent pastures, pastures grown in rotation with other crops and for silage or hay is an important aspect of livestock production in Latin America. The extensive grasslands are a vast natural resource in many Latin American countries.

(1) Production

The quality and quantity of forage produced in Latin America varies widely. Argentina and Uruguay typify areas with considerable development, but in most countries the range area consists of low quality native grasses with low carrying capacity and production per unit area.

Uruguay has a high degree of agricultural development, with 90-95 percent of the land area in forage production but it has less than 10 percent improved pasture lands

(Christiansen, 1965).

The limited use of new or improved varieties, grass-legume mixtures and rotations, fertilization and other management practices places Latin America in the early stages of development. Disease or insect resistant varieties have not been used extensively enough to improve forage production. Although present forage production is low, the potential of Latin American lands for high forage yields is good.

(2) Utilization

Forages can be utilized indirectly for man's benefit by ruminant livestock. In Latin America, these livestock are primarily cattle, sheep, goats, llamas, and horses. In quantitative importance, beef cattle are considered first. Dairy cattle and sheep are a distant second and third. Horses, llamas, alpacas, mules and some other animals are also important forage consuming livestock. This report will place emphasis on beef cattle.

The major method of forage utilization is through livestock grazing. It is probable that 90 to 95 percent of the forages of Latin America are harvested by grazing animals (Christiansen, 1965; Cox, 1966; Phillips, 1968). Animals are the most efficient harvesters of forage known to man particularly where mechanization is costly relative to the price of the animal or animal product.

Improved grazing systems are effective in increasing forage production. In Latin America, the most common system is continuous grazing with little regard for proper control of

stocking rates. This system results in over-grazing, deterioration of pasture quality, soil erosion, and reduction of livestock and livestock products. Use of strip, rotation, rotation-deferred and rest-rotation grazing systems is estimated at 10% of total grazing practices (McDowell, 1967 and Christiansen, 1965).

In Latin America, feeds are rarely harvested and stored specifically for use during times of need. This can be attributed to the relatively high cost of harvest and storage, lack of knowledge and equipment and the period of highest forage quality occurring during the wet season. Under drought or other possible stress conditions, where death loss is high and production curtailed drastically, it may be economical to practice some degree of harvesting and storage to meet the nutritional needs arising during conditions of stress.

b. Concentrate Feeds

Even though forages have been given emphasis, concentrate feeds cannot be ignored in improving livestock production. Concentrates are certain to become more important in the future to provide needed nutrients under specific conditons.

(1) Energy Concentrates

Few energy concentrates are used in Latin America with quantitative significance. Those which are used sugarcane, molasses, corn, grain sorghum and some other small grains are most important. In some areas by-products and crops residues from other crops, such as bananas, coffee, rice, and cotton supply some energy. Their use accounts for less than 10 per-

cent of the feeds used by the cattle industry of Latin America (Raun, 1968 and Thurston, 1969). Molasses is the most important contributor of energy feeds for the cattle industry with corn and sorghum grains second and third. Many Latin American countries have developed sizeable sugar cane and some sugar beet industries and molasses is an important by-product. Sorghums have drought resistant and regrowth characteristics, thus are more suitable than corn for production in most areas of Latin America. Sorghums have potential use for grain and forage production.

(2) Protein Concentrates

One of the most serious limitations of livestock production in Latin America is the availability and cost of protein feeds (Rourk, 1969 and Phillips, 1969). Most forages grown in tropical and sub-tropical climates are extremely poor sources of protein. The protein deficiency is even more pronounced when the plants advance in age and maturity is reached. It is common for forages being grazed by livestock to supply only one-half of the amount of protein required for optimum production conditions (Moore, et al., 1967). The problem exists with native and improved forage varieties. Protein rich supplement feeds are needed to increase the protein level in livestock diets. Plant origin protein rich feeds used in Latin America include products from cotton, peanuts, flax, soybeans and some other legumes. Some of these, particularly the soybean products, are imported and only small amounts find their way into livestock feeds. Fish meal, slaughter by-products

(meat, blood, bones, etc.) and some milk products are available. Their price is usually relatively high and limits their use in beef or dairy cattle diets. Synthetic (non-protein nitrogen) sources are available and used to a considerable degree.

Although no data are available on the amount of urea now being used in Latin America it could have an important role as a livestock feed and as a crop fertilizer.

(3) Minerals

Little evidence is available concerning mineral needs of animals consuming forages in Latin America. There are indications of serious problems. Forages are characteristically low in calcium. Soils in high rain-fall areas are normally low in phosphorus and other minerals. Studies in Latin America verify these conditions (Cunha, 1967 and Payne, 1970). Calcium and phosphorus are usually either deficient or not present in the proper ratio. In addition forages may contain inadequate amounts of magnesium, iron, cobalt, zinc, copper, manganese and iodine. Mineral supplements are rarely used to correct these deficiences. Even sodium chloride is not fed in many areas.

Minerals from mining or industrial by-products are not generally available. Regular use of mineral supplements would improve livestock production.

(4) Additives

Feed additives, growth promoting drugs and other chemicals are scarcely used in the beef cattle industry. It is estimated that less than one percent of the livestock in Latin coun-

tries are produced where growth promoting substances, other than disease combating medicines, are used. Growth response to administration of drugs or other chemicals is frequently such that excellent returns above cost are obtained.

In the U. S., diethylstilbestrol (DES) has repeatedly shown growth response of 10 to 18 percent with improvement in feed efficiency of 8 to 12 percent. The costs for DES are very small relative to production increases. To achieve good results nutrition and management practices must be improved.

3. Diseases and Parasites

Livestock diseases and parasites are believed to be responsible for lowering livestock production as much as 40 percent. Few animals are born with diseases or parasites. They usually acquire them through the introduction of unhealthy animals or improper sanitation, feeding, and management practices. Keeping animals healthy is primarily a matter of controlling the introduction of infection or infesting organisms by using sound principles of santitation, management, feeding, and by the proper use of dependable products for disease control and prevention. When problems arise, correct diagnosis by a veterinarian, the immediate and correct use of proven products and the prompt initiation of control and eradication measures will hold losses to a minimum.

a. Diseases

(1) Foot-and-Mouth Disease (aftosa)

Foot-and-Mouth disease (FMD) is present in most of the livestock producing countries of the world. Important exceptions are the countries of North and Central America. The di-

viding line is thought to be in Colombia near the Panama line. Surinam and French Guyana and the Caribbean Islands have evaded the disease in current times. The other Latin American countries are infested with the disease, which has not been a serious problem in livestock production despite its continued presence. Producers following rigid control measures by vaccination have learned to live with FMD without experiencing large losses in production. The disease is serious and presents problems and extra expenses and holds a constant threat of serious outbreak. The real problem lies in the market restrictions imposed on countries with FMD. To export to the U. S. for example, meat products must be sterilized of the FMD organism. This involves cooking, canning or in some cases special freezing processes. No fresh meat from countries with FMD are permitted in the U. S. Another example of the seriousness of the FMD problem is the outbreak experienced in Great Britain in 1969. An immediate ban on imported meats and animals from FMD infested countries and large numbers of infected as well as suspected animals were destroyed within British countries. It has been estimated that the livestock industry of the involved Commonwealth countries was set back 8 to 10 years (R. Poultney, 1971, FAO Panama, personal communication). The extra production costs, actual FMD losses, additional problems and costs in marketing are serious and FMD should not be underrated.

(2) Other Diseases

Brucellosis, stomatitis, anaplasmosis, piroplasmosis,

blackleg, anthrax, shipping fever, malignant edema, hog cholera, tuberculosis, paratuberculosis, equine encephalomyelitis, rabies, leptospirosis and mastitis are endemic in most areas of Latin America and occasionally reach epidemic proportions. The damage from disease is considerable, and their control and prevention should not be neglected.

b. Parasites

Losses from parasites may result in death and lower production levels. It is impossible to evaluate all losses from conditions arising from parasitic infestations. It is generally agreed that losses are extremely high in all countries of Latin America. The problem is most serious in tropical and subtropical climates.

(1) External Parasites

Ticks, blood sucking flies, mange, mites, lice, biting flies, screw worms, grubs and dermatobis hominis, are among the parasites producing losses directly or indirectly through disease transmission or aftermath infections. Improved pastures may increase the number of livestock maintained in a given area and result in parasitic infestation unless attention is given to husbandry. Attention should also be directed towards the danger of introducing types of parasites into a country which is free from them, through importation of livestock. In Chile, the tick family Ixodidae is prevalent and although the Boophilus type is found on cattle imported for slaughter purposes, it appears that this tick may not be adaptable to the conditions in the country. Trypanosomiasis does

not exist in cattle in Chile, nor are Dermatobia or Hypoderma found. In connection with Hypoderma, it has been noted that, although imported cattle sometimes carry larvae, the adult fly does not develop (Phillips, 1936).

Thysanosoma actinoides is commonly found in sheep as are hedatidosis, trichnosis, and cysticercosis. Campaigns are in operation for the control of hydatidosis. Distomatosis in its acute phase is responsible for deaths in sheep. The disease is now being controlled in both cattle and sheep. Parasitological investigations are carried out at the Institute of Veterinary Research.

In El Salvador, external parasites are among the principal causes of livestock losses. In the case of ticks, Boophilus spp. and Amblyomma spp. appear to be the most common but there has been no study of their distribution.

In Jamaica, the ticks commonly found are Boophilus annulatus (var. microplus) and Amblycomma cayennense in cattle; Dermacenter niteus in horses; and Rhipicephalus sanguineus in dogs. There are no rickettsial diseases (Phillips, 1956).

In Peru, no marked official effort has been made to control parasites and parasitic infestations. However, some work is underway. Mortality has been reduced from 26 to 2.5 percent; the average wool yield has been raised from 3.5 lbs. to 6.5 lbs., and the average carcass weight has risen from 24 to 42 lbs. (Phillips, 1956).

In Uruguay, so far as ectoparasites are concerned, mange (scabies) and lice infestation are no longer problems, but

tick control is still of considerable importance. A new law is about to be enacted regarding tick control. With the improvement of pastures, it will be possible to concentrate more sheep in a given area.

In Venezuela, as in the majority of the American countries the livestock suffer from the pernicious effects of ectoparasites, the most important among which are Amblyomma cayennense, Boophilus microplus, Dermatobia hominis, Lyperosia iritans and Stomoxys calcitrans. The Venezuelan Ministry of Agriculture, through its Ectoparasite Department, has been conducting intensive control of these parasites since 1936 (Phillips, 1956).

(2) Internal Parasites

Internal parasites are a very serious source of loss to the livestock industry as they infest about 99 percent of the animals. The principal ones are: in cattle, Haemonchus contortus; in horses, Strongylus spp.; Cysticercus celluloae (affecting approximately 15 percent of the hogs) and ascaris lumbricoides but no Trichinella spiralis in swine; Coccidia and Haeterakis gallina in poultry. Individual farmers are using anthelmintics such as phenothiazine, kamala and carbon tetrachloride in an effort to combat internal parasites.

4. Economic Factors

The livestock industries have traditionally been part of Latin American agriculture since colonial times. In only a few countries, however, have livestock been of major importance in the national economy. In recent years, governments of many Latin

American nations have given priority to livestock development programs. Expansion in livestock production, especially beef cattle, has been viewed as a desirable goal in increasing self-sufficiency in food production and developing new export lines to earn needed foreign exchange. Increased emphasis on livestock improvement has led to considerable financial assistance and large livestock development programs in many Latin American countries.

This section deals with the economic factors currently affecting Latin American livestock industries. Consistent with other portions of the report, this section will be primarily concerned with meat animals, especially beef cattle.

a. Production, Utilization and Trade

Meat production increased gradually in most Latin American countries during the past decade, not quite staying even with population growth. Pork production grew somewhat less than population, so that per capita consumption declined in nearly all countries. Production of lamb and mutton increased about the same as population (Florida, 1970 and USDA, FLM 1 & 4-69, 4-70, 1-71).

Beef represents the largest share of Latin American meat production and utilization. Total beef production increased slowly during the 1960's, providing growth in per capita consumption and exports in only a few countries. Generally, beef production was not great enough to maintain consumption levels of the 1950's.[1]

[1] Current beef supplies, at present income levels, allow less than 20 kilograms (44 pounds) of beef per person annually in all tropical Latin American countries.

Only Jamaica, Panama, Peru and Venezuela showed significant increases in per capita beef consumption (Florida, 1970 and USDA, FLM 1-71). These increases were due primarily to increased imports. With growth in consumer incomes, these countries were able to import beef and other meats, mainly from other Latin American nations. Mexico, Brazil, and the Central American countries expanded exports significantly during the past ten years, but at the expense of domestic consumption. The traditional exporters, Argentina and Uruguay, also expanded their beef trade with other nations in the region.

Livestock and meat trade between the United States and Latin America grew substantially during the past decade (Florida, 1970 and USDA, FLM 9-70 11-70). Most countries in the region increased their imports of breeding stock of all species from the U. S. The United States also became an important supplier of processes meats to the Caribbean nations, and a large shipper of by-products to a number of Latin American countries. A large proportion of Central American beef exports went to the U. S., as well as numbers of feeder cattle from Mexico (Rourk, 1969). Argentina, Brazil, Uruguay and Paraguay continued their export of processed beef to the United States, along with wool and some by-products.

b. Marketing and Marketing Systems

Livestock production in the tropical countries of Latin America has already been characterized as generally traditional and changing only slowly. Beef, for example, is produced mainly from cattle grazed on native or partially-improved pasture. Forage production is highly seasonal due to pronounced rainfall

variation. Herd productivity is limited due to low calving rates and high death losses. The majority of cattle are essentially Criollo type, and are typically of small size, light weight and slow maturity. Cattle generally require five years to reach slaughter weights. Many animals are raised in extensive ranch operations in remote regions and moved to growing areas near consumption centers for fattening and eventual slaughter. Substantial proportions of beef consumed in many countries come from multi-purpose cattle that produce light, low-grade carcasses (Dow, 1971 and Mathis et al., 67-2).

Marketing systems for all livestock and meat are equally traditional and unorganized. Beef marketing in most countries can be considered typical of the total livestock marketing system prevailing in Latin America.

Beef consumed in rural areas and smaller cities is typically from cattle slaughtered daily in municipal abattoirs or private facilities. Usually the hide and some of the edible by-products are sold, with the remaining offal thrown away. Refrigeration is seldom available and sanitation is minimal. Carcasses, frequently broken into halves or quarters, are taken directly to retail butcher shops in the public markets.

Capital cities and urban centers receive somewhat heavier cattle, often of higher quality than outlying towns. Slaughter facilities range from shade-tree butchering to fairly modern plants equipped for export. The majority of beef consumed in urban areas is also from butcher shops in the marketplaces selling cuts from freshly-killed cattle.

Very few countries have an orgainzed marketing system for live animal concentration and movement. Retailers buy live animals direct from producers or from cattle traders. Most slaughter, whether in municipal facilities or private plants, is on a custom basis for a retailer or trader-wholesaler. These operators perform the meat distribution function in most countries.

Consumers generally purchase small quantities of fresh meat daily. Most families in tropical Latin American countries do not have home refrigeration. Substantial amounts of cured and processed meat products are also consumed, particularly in Caribbean areas.

Processed meat producers are important export items for some Latin American countries, along with frozen boneless and carcass beef. Marketing elements handling export producers differ from those distributing beef for domestic consumption. Larger capital investment in facilities and equipment and a greater requirement for skilled labor distinguish the export sector. These factors, and the beef quality, volume, and stability of supply necessary for export, exert considerable influence on a national livestock industry. The extent of this influence, and the effects on national economic development, depend in considerable degree on government policies pertaining to the livestock industry. Policies affecting domestic supply and demand elements also help shape a livestock industry's contribution to overall development.

Certain types of policies affecting beef production and supply are prevalent throughout Latin America. Aside from devel-

opment programs, which will be discussed separately later, certain government edicts have a direct bearing on beef supply and trade. Most government regulation concerns domestic beef supplies and prices. Several governments prohibit or severely limit slaughter of breeding age females, and a few nations require a minimum level for domestic slaughter. A number of Latin American nations regulate prices for live animals and impose maximum retail beef prices (Florida, 1970 and McPherson, 1970).

Most tropical Latin American countries restrict exports of beef and/or live cattle in some manner, to insure a certain minimum domestic supply (McPherson, 1970 and Rourk, 1969). Colombia, however, has policies encouraging beef exports to earn currency exchange (McPherson, 1970). Some Latin American nations exporting beef to the U. S. are parties to voluntary limitations imposed by U. S. legislation.

Most tropical countries in Latin America include livestock imporvement in their overall agricultural development and diversification efforts. Only a few can really be said to have a national livestock development program actually operating, however (Florida, 1970; McPherson, 1970 and Rourk, 1969). Beef industry improvement efforts have been directed mainly toward financing capital improvements (pastures, fences and so on) and imports of breeding stock. Some supervised credit programs and research and extension services are provided. International lending agencies have provided large amounts of capital for livestock development to several countries at various times. The efforts have generally been uncoordinated and had little con-

tinuity. Most have not been soundly based on adequate research and problem identification. As a result, very few countries have much beef industry improvement to show for past investment.

B. Potential Production Levels

In assessing possibilities for improving livestock production in Latin America, one must consider: 1) forage production; 2) availability of supplemental nutrients for balancing diets; 3) livestock markets; 4) climate; 5) cost of technology; 6) disease and parasites; 7) genetic potential of livestock; 8) national taxing policies; 9) national customs or policy and 10) management practices. The above considerations for livestock production are not all-inclusive nor are they listed in order of importance.

The Latin American livestock industry is large in terms of numbers, but is low in production output. To illustrate this, some comparisons between the U. S. and Latin America are presented. Latin America and the U. S. have about the same number of people, just above 200 million (Thomas, 1964). The land area in Latin America is about double that of the U. S. The U. S. has 100 million beef cattle while Latin America has 200 million beef animals. Latin America produces about 5 million tons of beef meat per year while the U. S. produces more than 10 million tons (Cox, 1966). The productivity ratio is 1 to 4, i.e. Latin America requires 4 times as many cattle to produce a given quantity of meat as the U. S. In Latin America slaughter rates vary from a low of 5% or less in some areas to a high of 20% in Argentina with an average of 10-20% compared with 35% for the U. S. (Christiansen, 1964 and McDowell, 1966). Considering the lighter market weight for livestock in Latin America, the productivity

ratio is again 1 to 4.

The question is to what extent can this gap be closed or how much more efficiently can livestock be economically produced in Latin America? Data from research trials, private and commercial ranches indicate the following, improvement levels would be obtainable through out the industry (Christiansen, 1964 and Cox, 1966).

1- Calving percentage could increase from 50-60% to 80-85%.

2- Weaning weights could increase from 125-135 kg. to 175-200 kg.

3- Age at slaughter could decrease from 4-5 years to 2 1/2 - 3 years.

4- Weight at slaughter could increase from 380-400 kg. to 450-500 kg.

5- Meat quality could improve from an average grade of standard to a grade of good (based upon U. S. grading standards).

6- Cow life productivity could increase from 500-550 kg. to 1100-1200 kg. of calf produced.

These estimates are based upon realistic appraisals of Latin America livestock production potential. The beef cattle industry has been used as an illustration, but similar improvements can be experienced in the swine, dairy, sheep and possibly other livestock or poultry enterprises. Improved efficiency could reduce the number of livestock which would reduce the grazing pressure and allow improved forage production. Livestock numbers might be maintained or increased by opening new land areas and increasing the carrying capacity of existing pastures by improved forage production and management practices. Large tropical areas of Latin America are still undeveloped. Some say this is a handicap for livestock production in Latin America, however, considering the climate and topography of these vast tropical areas, many believe they hold a tremendous bank of resources for live-

stock production. It appears that production efficiency improvements of 300 to 400% are possible for Latin American livestock industries especially for animals that utilize roughages.

The following table is included to illustrate the various productivity levels achieved in different areas of Latin America and to indicate the differences possible with various management levels within an area.

Table -- Comparison of physical productivity indicators for different Latin American countries and beef production systems [a]

Country and system	Extraction rate[b]	Production per hectare	Production per man-year
1. Venezuela (western Llanos 1971			
Average management	7.3	9.4	5.0
Improved management	16.3	13.0	13.7
Intensive management	22.4	190.3	19.6
2. Venezuela (western Llanos 1966			
Average management	8	8	7.5
Good management	14	13	10.5
3. Argentina (B. A. Province)			
Average managment	30	90	18.0
Good management	33	150	25.0
4. Uruguay			
Average management	20	85	20.4
Good management	29	140	33.6
5. Paraguay (eastern Chaco)			
Average management	17	18	25.7
Good management	20	30	42.9
6. Brazil			
Average management	13	11	11.0
Good management	22	36	12.0
7. Colombia (Llanos)			
Average management	11	11	9.7
Good management	23	35	21.8
8. Dominican Republic (East)			
Average management	22	14	18.6
Good management	31	120	41.4

[a]Information from Dow, 1971; Mathis et al. 67-2 and Mullenax et al. 1969.
[b]Animals Marketed per 100 animals in herd.

III. Production Principles (Universally Applicable)

A. General Discussion

This report assumes that the proper use of the vast amount of grasslands in Latin America is for forage production. It is also assumed that the forages produced are best utilized by livestock to produce meat and other products utilized by man (Raun, 1968; McDowell, 1966; Cox, 1966; Christiansen, 1965; Thomas, 1965; Cunha, 1965; Stonaker, 1970; Blydenstein, 1970, and Phillips, 1956 & 1969). Livestock production based on forage consumption is extremely important in Latin America. Production efficiency in the livestock industry is far below potential levels. The major question of concern is how can production of livestock products, primarily by forage utilization be significantly improved in Latin America? This report attacks the problem from the concept of the "total package" approach, in which all of the major limitations of livestock production are dealt with simultaneously avoiding the use of priority ranking.

The major aspects of livestock production which will be simultaneously emphasized are: 1) utilization of present resources i. e. feed supplies and livestock 2) improvement of resources, that is producing more and better feeds and better livestock, 3) increase of product demand, from the aspect of human protein foods and from a quality and quantity basis, 4) improvement of livestock production, as influenced by nutritional factors, such as, forages, crop residues, supplements, other feeds and growth stimulants and by management principles, such as, reproduction, disease and pest control, calving and calf growing problems 5) improvement of marketing for the product, as effected by market demand (consumer satisfaction), producer profits and economical

impact to the consumer as well as the country.

Research data, study reports and opinions of several investigators state that forages are the most abundant natural resource for agriculture in Latin America (McDowell, 1966; Christiansen, 1964; Cox, 1966; Phillips, 1956; and Stonaker, 1970). Reports state that as much as 90-95% of the animal feed is supplied by forages of which more than 90% are harvested through grazing (Christiansen, 1965; Cox, 1966; and McDowell, 1966). Regardless of potential crops and other land use, most of the Latin American topography is such that the grazing animal offers the only realistic way of harvesting plant resources (McDowell, 1966; Christiansen, 1965; Cox, 1966; and Raun, 1968).

There are several methods that lead to increased production of forages: 1) improved varieties, 2) better grazing systems, 3) renovation, 4) fertilization, 5) conservation practices, 6) grazing or mechanical harvesting of some cultivated crops. Efficient forage production and utilization for Latin American livestock production cannot be over-emphasized.

Beef cattle will be used as the animal of discussion in this report because of their widespread use in Latin America, their relative economic importance and their unique ability to thrive on forages when properly used. In many areas of the world, particularly in well developed societies, beef supplies more than half of the meat portion of human diets (Moore et al., 1967; Thurston, 1969 and Rourk, 1969). Economists, demographers and other international specialists predict greater demand for beef in the future (Phillips, 1969; Cunha, 1967; McDowell, 1966; and Mathis, 1968).

Each aspect of livestock production presented will be treated with equal emphasis. There are differential costs involved, differential improvements attainable and differential time requirements associated with the various aspects of livestock production. To illustrate the importance of the "total package" concept let us consider the examples of a livestock enterprise that does an excellent job of livestock feeding, disease control and pasture management but uses non-fertile bulls. The results are obvious: no calves. The "total package" approach is emphasized in this report as a means of overcoming production limitations due to one or more ignored phases of the livestock system.

B. Present Resources

A viable population of animals and an adequate supply of feed is basic for a livestock industry. Nature has done a respectable job with her wild animals for thousands of years, without man's help. We like to think that man can improve nature's system, but there are examples of deterioration as well as improvement as a result of man's contributions to the natural systems.

1. Feed Supplies

In comparison with the U.S. (1,902 million acres), Latin America has more than twice the amount of land (4,000 million acres). In the U. S. about 60 percent of the total land area is devoted to production of animal feeds, including 49 percent for grazing purposes and an additional 11 percent devoted to the production of grain, hay and other forage crops (Ensminger, 1969). Figures are not accurately known for Latin America but about 60-70 percent is thought to be devoted to the production of animal feeds. Calculations indicate that about 2,400 million acreas of Latin America are presently used in production of feeds for livestock. Of the land producing live-

stock feed about 90-95 percent is devoted to forage production of which 5 to 8 percent is improved grasslands (Phillips, 1956 and 1969; Christiansen, 1964). Latin America possesses tremendous amounts of livestock feed resources nearly all of which arise from unimproved or native forages.

How can available forages be utilized best? It seems that ruminant livestock, principally beef cattle produced under proper management systems for all phases of feeding, breeding, disease, insect control, and marketing are the best systems for utilizing forages. The resources, feed and livestock, are readily available throughout Latin America. Also, the need or market for the product is present. Emphasis must be placed upon application of better production principles to enhance utilization of the available resources.

The best methods of forage utilization are not known for all locations and conditions. However, certain basic principles of forage utilization are known and have been universally applied with good results. The problem is to insure food growth and utilization of the plant resources. This includes plant nutrition, soil fertiliity, controlling plant competitors, such as weeds, insects and diseases, plant longevity, differential plant associations and proper harvesting methods. The researcher must keep these basic facts in mind and search for the best method or system to satisfy them. The task of solving the problem is not easy. Research programs should be aimed towards finding ways of applying proven principles rather than searching for new principles. The approach of this report is intended for developing countries and may or may not be applicable to the U. S.

2. Livestock

The U. S. has about 110 million head of cattle; Latin America has about 230 million head (Cox, 1966). Latin America and the U. S. have about the same number of people (215-220 million). The ratio of cattle to people in Latin America is about 1 to 1 while in the U. S. it is .5 to 1. Latin America produces about 5.5 million tons of beef per year and the U. S. about 11.5 million tons. Latin America is feeding 4 times as many cattle to produce a given quantity of beef as the U. S. Slaughter rates in Latin America are about 35-38 percent in the U. S. (Christiansen, 1964 and Cox, 1966). What this means is that for every 100 head of beef cattle in the U. S., 35-38 animals are sold for slaughter each year. In Latin America only 12-14 animals are sold for slaughter yearly for every 100 animals maintained. An abundant quantity of livestock is available in Latin America. In fact, some people argue that there may be too many livestock. However, the purpose of the given statistics is to help varify that livestock are indeed abundant in Latin America.

A common solution for the above problem is to attempt to improve the quality of livestock. This in many cases has helped. All to often, however, the results have not been rewarding. When diseases, parasites, nutrition and other management practices have not been improved, new and so-called better quality animals have failed to improve production. In many cases production has actually decreased. It is important to emphasize that these statements are not aimed at reducing the importance of better livestock. On the contrary, better livestock are essential. However, it is essential to improve all or most of the limitations to production simultaneously in order

to insure genetic expression.

As was pointed out earlier regarding feed supplies, the scietists attempting to solve problems in Latin America must take the simplest most natural approach. More than 400 million cattle are in Latin America and well above 75 percent are unimproved (Payne, 1970). These are the livestock resource and the major thrust of research emphasis should be placed on ways and means of improving production levels of livestock already in Latin America. The researhcer should apply basic scientific principles to help solve the problems. In nutrition the problems are to supply in the proper amount and combinations, protein, minerals, energy, vitamins and water. For reproduction regulation of the breeding time and subsequent calving season, controlling the quality and quantity of sire-dam (breeding), awareness of and correction of gestation, parturition and lactation problems and other management associated aspects must be implemented to improve conditions. Control of diseases and parasites with vaccines; adjusting animal and environmental associations to reduce stress factors; proper use of drugs and medicants and application of other practices reducing harmful effects must be part of the system of improvement. These statements are not all-inclusive, but are presented with the purpose of expressing the idea and overall concept of livestock improvement without necessarily introducing new animals and new feeds. The following section is devoted to improving the livestock production resources.

C. Resource Improvement

It is readily recognized that even though perhaps the least costly and most significant improvements in livestock production can come from

the present feed and animal resources, looking at the future, more and better feeds and better livestock are emminent. It is important to indicate that the full scale of livestock production efficiency is present in many areas of Latin America. Present weaning weights vary from 100 to 250 kilograms; calf crop percentage from 30 to 90%; market age from 18 months to 6 years. To a researcher this is encouraging from the standpoint of potential improvement. When wide variations, such as these, exist within an area, application of sound selection systems, proper nutrition, disease and parasite control and other management tools properly practiced, significant increases in production efficiency are certain. The above statements apply to animals and plant improvement in both quality and quantity.

1. More and/or Better Feeds

Even though the "total package" approach is emphasized in the report, the importance of quantity and quality of livestock feed are emphasized. If limitations on livestock production were ranked in a priority, most people would place forage production and improvement first. Although forage production will continue without much effort on the part of man, its nutritive value and yield per given land area may be improved by the application of appropriate decisions and management practices.

There are many ways to achieve the goal of more and better forages. Some examples are given: 1) management of soil; plant association for improved and unimproved; 2) control plant stress factors, disease, insects, over-grazing, etc. 3) provide plant varieties with increased disease resistance, productivity, palatability and digestibility, 4) management of plant: to plant associations, particularly grass:

to legume mixtures, 5) proper harvesting methods, such as stage of maturity and season of year. Regardless of the method applied, the basic principles must be employed. Any plant to express its potential, is dependent upon its environment first and its genetic make-up second. Therefore, the fundamentals of soil fertility, moisture, sunlight, disease, plant competitors, etc., must be dealt with accordingly. When these factors are conducive to good plant growth, improved or unimproved varieties of forages can be expected to respond favorably. In general, improved varieties respond to a greater degree than unimproved. Unfortunately, this is usually true with regard to decreased production resulting from stress factors as improved varieties decrease more drastically than unimproved.

As emphasized earlier in this report, the least costly and most immediate response in increased livestock production will come from proper management of the now present livestock and livestock feed supplies. However, keeping in mind the "total package" approach, it must be emphasized that to keep pace with world changes (which stress the need for productive efficiency) it will be necessary to increase yields of forage per unit of land, increase nutritive value of the forage produced and increase the efficiency of conversion of forage nutrients to animal products.

There is an opinion among animal scienctists and forage plant scientists that total forage intake is more important than forage digestibility (Moore, 1968; Preston, 1968; and Reid, 1961). In an article relating the importance of voluntary intake Preston (1968) states that a serious limitation in beef cattle production is the relatively low intake level. There is another opinion that the most

important limitation in beef cattle production is simply a matter of total digestible nutrients per unit of land (Torres and Gil, 1971; Argentina, Personal communication). When applied correctly both approaches are sound measures in attempting to increase livestock production through forage utilization. In a presentation prepared by Moore (1968) it was pointed out that digestibility and intake are related, but intake is the more important factor in comparing the nutritive value of various forages. While energy digestibility (TDN) increased by only 36 percent when changing from lowest to highest quality forage intake increased by 250 percent, or 6 times that of digestibility. Therefore, there may be a greater opportunity to improve the performance of ruminants fed roughages by selecting forages for intake rather than for digestibility.

Though there is validity of both approaches expressed above, their immediate application is certainly more appropriate under well developed livestock industries than is commonly present in Latin America. This is not to imply that they should be ignored in Latin American livestock development. On the contrary, both approaches (increasing TDN per land unit) and (selecting forages for voluntary intake rather than digestibility) have a place in improving livestock production in Latin America, particularly as the industry develops and modernizes.

Perhaps more important within the scope and purpose of this paper, is to magnify the importance of applying these principles to Latin American conditions. Presently, more than 90 percent of the grasslands in Latin America are native or unimproved forages. The question arises then, is it possible to increase TDN per land unit using native or unimproved forages and can voluntary intake of

native or unimproved forages be increased? The answer to this question is in the affirmative. Then we once again come to the point of stressing the importance of applying production principles. More and/or better forages can be realized regardless of whether one is dealing with improved or unimproved forage. The thesis herein is that for more immediate and least costly improvements the vast quantity of presently established forages must be dealt with equal importance and considered simultaneously, but perhaps different in terms of the degree of practice and applicable time span. Development programs must include improvements of both quality and quantity of forages. The quality and quantity attributes of forages can be determined in terms of voluntary intake, digestibility, productive efficiency, animal performance and most important total product per land unit per year.

2. Better Livestock

Although the importance of applying good practices appropriate to livestock production operations with native or relatively unimproved animals has been stressed, de-emphasis of improving livestock is not intended. Livestock improvement is important in Latin America and other areas of the world. More important are the methods used for livestock improvement. The methods with the most immediate response, least cost and minimum amount of complexity are considered most appropriate for Latin America. Application of sound production principles must be emphasized to insure expression of animal ability. This concept is valid with any type livestock.

To illustrate this point some of the production principles are presented and discussed. 1) Nutrition. If low quality animals are

fed inadequate amounts of protein, energy, minerals or vitamins it is certain to be reflected in reduced growth and/or other productive measures. Likewise, if good quality animals are treated similarly it is certain to be reflected in reduced growth and/or other productive measures. Nutrient requirements for animals based upon metabolic size is similar for all animals within a particular species regardless of their productive potential (NRC, Nutrient Requirements of Beef Cattle, 1970). It is important to recognize the diet must be nutritionally adequate to permit expression of genetic potential. Similar limiting effects are found when other environmental factors impose restrictions on production. It is generally agreed that animals producing poorly as a result of environmental stresses, respond more favorably to good selection practices (coupled with removal of environmental stresses) than animals accustomed to reasonably good environmental conditions. This fact is important for Latin America, since the majority of its livestock is produced under a great deal of environmental stress conditions. Many stresses, such as poor nutrition, lack of diseases and parasite control and inadequate management practices, can be improved and thus permit better expression of more productive traits of livestock. Immediate emphasis should be placed on improvement of the present livestock resources available. In the long run, improvement of livestock by introducing new genetic material and/or using extensive crossing systems in the breeding program, should be regarded as an important part of the "total package" approach.

This question will undoubtedly be asked: what about past and present programs for introduction of new genetic stock into Latin

America? Past and present programs have made contributions and will undoubtedly continue to do so. It is recognized that livestock breed development and new-breed establishment has been due largely to the efforts of wealthy individuals or organizations. Research institutions have also made contributions towards breed improvement and creating new breeds of livestock. These programs are very costly and in general, Latin American research institutions or livestock producers, cannot afford the time nor the expense involved. More beneficial progress can be achieved by devoting efforts towards applying the basic tools of livestock improvement to the animals now present in Latin America (Raun, 1968; Stonaker, 1970; and Christiansen, 1965).

3. Livestock Production Practices

As used in this report livestock production practices includes all phases of nutrition, reproduction, disease and parasite control and other management practices involved in raising livestock from conception to the finished live animal product for slaughter. Marketing the product is covered in a later part of this section. Since these phases of livestock production have been dealt with in detail in other parts of the report, the application of scientific principles to bring about improvement of livestock production will be emphasized in this section.

The cattle conception rate in Latin America is generally very low. Even though some areas (in Argentina and Uruguay for example) may realize 75 to 80 percent conception rate in cattle, other areas (in Brazil, Mexico and Peru for example) are realizing only 30 to 35 percent conception. For Latin America in general 45 to 50 percent

calving is often stated in the literature (Christiansen, 1964; McDowell, 1966; Rourk, 1969; Payne, 1970; and Shackford, 1970). Calving percent and conception rate, even though they often vary considerably, are related and the same limitations are often common to both. In order to obtain respectable production levels through reproduction certain basic principles must be applied. Some of these include fertile bulls and cows, good nutrition, disease and parasite control, good quality bulls and cows and suitable environmental facilities for breeding and calving. Other factors could be listed, but the researcher should determine the all-inclusive list of production limitations and find the best methods to correct them for his specific location and set of conditions.

When the animals are born, nutrition and disease and parasite problems are immediately manifest. If the calf does not receive vital nutrients (proteins, energy, minerals and vitamins) and sometimes antibiotics, it will not survive or grow satisfactorily. The nutrition and health problem confronts the calf throughout his life. Domestic animals, rarely achieve acceptable production levels without proper help from man. The world is equipped with adequate man power and intelligence to overcome livestock production limitations if the knowledge is applied.

Forages are by far the major source of livestock feed. Any production principle or management practice that will economically improve production and/or utilization of forages in Latin America should be applied. Scientists must consider the availability, palatability and digestibility of forages. Forages are relied upon to satisfy the basic nutrient needs of most livestock for the major

portion of their lives (Christiansen, 1965; Cox, 1966; McDowell, 1966 and Rourk, 1969). Forage palatability is likely one of the most important factors limiting livestock production efficiency (Moore, 1968; Preston, 1968 and Reid, 1961). Digestibility of forages is usually 50 to 60% (NRC tables of Feed Composition) and is influenced by stage of maturity, season and total voluntary intake.

Can application of basic management principles influence availability, palatability and digestibility of forages regardless of forage type and if so, will they lead to significant improvement in livestock production? In answering this question let us draw on generally known results of applying improved management practices in other parts of the world. The early history of the intermountain area of the U. S. serves as a good example for increasing availability. Early settlers found ideal range forage conditions. As a result livestock numbers grew rapidly and eventually out ran forage supplies. Overgrazing resulted. Following was a chain of events which led to a disastrous decline in range livestock carrying capacity. Livestock numbers were reduced by 200 and 300 percent before the trend was reversed. After 20 to 30 years of controlled stocking rates and improved grazing systems, the intermountain ranges, in general, are once again back to a high level of forage production. Feed supplies and grazing livestock have been brought into equilibrium.

This kind of story can be told in many places throughout the world. Overgrazing not only reduced total available feed but because of animal preference, grazing pressure is greatest on the

preferred forages. As a result, the preferred more palatable forages disappeared while lower yielding, less palatable and less digestible forages took their place. The principal difference between the intermountain area of the U. S. and a large amount of Latin America is that the improvement can be brought about more rapidly in areas of higher rain fall and with longer growing seasons. The intermountain area of the U. S. generally receives 15 to 18 inches of precipitation and has less than 6 months of good growing weather per year. In much of Latin America, precipitation exceeds 30 inches per year and the growing season is nearly year round.

Fertilization and grazing at the proper stage of maturity and season also have pronounced effects on forage availability, palatability and digestibility. Though it is not a widespread problem, understocking has detrimental effects particularly on palatability and digestibility. So-called shock-grazing, where a large number of livestock are confined to a relatively small area, results in all of the forage being grazed. The animals are then removed for a period of time to allow all forages to regrow. This system allows the more preferred plants to regrow and prevents over-competitiveness of the less desirable plants.

In any system of livestock production, there is a given amount of animal units, which reflect a given amount of live animal protoplasm. In order for this mass of animal protoplasm to grow and produce satisfactorily, it requires a given amount of available energy, protein, minerals and vitamins. Assuming other factors such as diseases, parasites and other stress factors are controlled adequately, the animal protoplasm (live beef cattle) will grow and produce

when the nutrient requirements are met. The exact response varies with the individual animals and feeds used. However, all animals will perform better with better conditions; any kind of feed will produce more product when properly utilized; and any kind of land will produce more feed if correct management principles are applied. All research and development programs should be planned towards improvement of the resources involved, but too often improvements for the future receive the major thrust and the present realistic situation is ignored.

Some may argue that the above approach is over-simplified and does not apply solid scientific principles. This may be true for highly developed agriculture production systems, but one must consider the relative conditions of animal agriculture in Latin America. It appears most appropriate to consider Latin American agriculture as it is and plan development programs to fit into the present systems. All applicable technology should be integrated within the system, all phases of livestock production treated with equal emphasis and simultaneously so that the response of a "total package" program can be realized.

D. Product Demand

World leaders recognize the potential increase in mass starvation if food production does not keep pace with population and other demand pressures. From a nutritional viewpoint, protein is expected to be the foodstuff to first become limited. Emphasis on cereal and oilseed proteins as contributors towards world protein needs and relagating animal agriculture to a lesser category of contribution to world food deficits, indicates a failure to understand the impact

of feed inputs in livestock production. The ability of livestock to use forages and other feeds inedible to humans with a limited amount of cereals can enhance the efficiency of protein production for humans in terms of total food resources (Moore et al., 1967).

Phillips (1969) states that to sustain the world's population at its present unsatisfactory level, food supplies will need to be increased by 36 percent by 1975 and by 123 percent by the year 2000. He further indicates that Latin Americans consume about 75 to 90 percent of the total calories and about 65 to 70 percent of the total protein required to meet their minimum daily requirements. People from the U. S., Canada, New Zealand, England and Australia consume an average of 60-62 grams of animal protein per day per person. The average Latin American while variable (Argentina 58 grams and Peru, 12 grams) consumes less than 20-25 grams of animal protein per person per day. Considering the above statistics and the trend for population to increase more rapidly in less developed countries, than in the world as a whole, the demand for more food of better quality and for high protein foods is a certainty. Regardless of the fact that livestock are poor converters of feeds to human edible food, the ability of livestock, particularly ruminants, to convert forages, inedible to man, to high quality foodstuff seems sufficiently important to justify their existence. In addition to forages, ruminants effectively convert by-products and crop residues from harvesting or processing of food crops, by-products from processing of animal products and non-protein sources of nitrogen to protein foods for man. The demand for livestock products does exist and will continue to grow.

E. Product Marketing

The characteristics of traditional marketing systems mirror those

of the producers whose output they distribute. Both groups are characterized by a low level of output and technical efficiency, limited capital resources, absence of standardization and inadequate facilities (Moyer, 1965). In a poor economy, with a relative scarcity of goods, markets are generally stable. Selling is simple, and consumers make do with the limited quantities -- and often poor qualities -- of products offered.

The complementarity of production and its supporting marketing-distribution sub-system becomes obvious. Changing marketing firms through added capital, different institutions or greater scale of operations cannot transform either supply or market conditions. Suppliers, distributors and consumers must transform themselves in tandem. Several investigators have concluded that it is fruitless to induce development in the productive sector without insuring that complementary advances are made in the distributive sector (Moyer, 1965).

Marketing is taken to mean all the facilities and activities associated with the exchange of goods and services, either for consumption or for use in production (Mehren, 1959). Thus, this exchange process is important in Latin American livestock industries both for sale and distribution of livestock and meat and of inputs required in the production process. The influence of improved marketing can be emphasized by stating that agricultural producers are concerned with the terms of trade between the commodities they produce and the commodities they purchase and not just with the prices of what they sell (Mellor, 1966).

Aside from improvement in roads and related infrastructure, and a

few scattered incentive policies, livestock and meat marketing have changed little in centuries. This may not be so surprising if it is recalled that the livestock and meat marketing system of the United States began to exhibit dynamic and substantial change only after World War II. Many elements of the U. S. system remain highly traditional, and others have modernized only recently. Little consumer refrigeration, small quantities of freshly-killed beef sold from local slaughter in small butcher shops, trailing cattle to market, five year-old market steers and low productivity were all found less than fifty years ago in the United States.

Both production and marketing of livestock and livestock products seem less amenable to rapid improvement through application of modern technology than do many crops and their products. Animal production and biologic processes are more complex and longer term. Resources necessary to identify and induce change are greater. The relatively minor role livestock have played in most tropical countries has helped to foster neglect. Low meat consumption in tropical Latin American nations has prevented much demand impact on production or marketing, and little is known of consumer desires relative to livestock products.

The quantity of meat which consumers in tropical Latin American countries will demand is expected to increase as domestic incomes rise and foreign demand grows. Recent studies project domestic meat consumption to increase at a rate proportional to population growth and income increases. In Central America, for example, demand conditions for beef were judged favorable in a recent study (Battelle, 1969). Export potential to the U. S. was expected to be the major stimulus for greater beef production, even though domestic demand was projected

to grow.

Many studies and projections lay stress on the lack of knowledge concerning important demand factors. Meat, and beef in particular, is income-elastic, but the degree of response to change in consumer incomes has been estimated in few Latin American countries. Likewise, price elasticity of demand is unestimated for different population and income groups in most nations. Reasonably accurate and reliable estimates of these measures would allow informed projections of likely quantities of meats required for domestic consumption. Demand estimates for different regions and income groups can be used in guiding modernization in specific areas of production and marketing. The impact of income increases resulting from overall development programs on the livestock industries can be estimated if usable demand data are available.

Conclusions regarding factors required in marketing system improvement are less clear than for the production sector. The lack of demand studies just mentioned and the scarcity of marketing research previously described make identification of development strategies more difficult. A few research efforts should be useful in this respect.

Two studies of food marketing in Puerto Rico (Galbraith, 1954 and Wuhrman, 1966) allow some tentative conclusions regarding meat marketing and demand. The food marketing system in Puerto Rico of two decades ago was similar in many respects to that of most Latin American countries then and now. The first economic studies involved a model food system, composed of the optimal retail unit, the optimal wholesale unit, and an estimate of the saving that could result if the food system was rationalized. Specific policy measures to im-

prove marketing efficiency were suggested (Galbraith, 1954).

From the research efforts and policy actions, a modern, efficient food marketing system was developed in Puerto Rico. More recent research found that the size and scale for marketing firms had increased, and the food industry had increased the number of workers it employed. Production and marketing costs for fresh eggs and milk had been reduced, and product quality improved significantly. While not determining specific causality, the research indicated that marketing performance changes accompanied government market programs and private marketing developments. Additionally, excessive numbers of small marketing firms were found to hamper productivity improvement and inhibit agricultural and marketing development (Wuhrman, 1966). Other studies confirm the need for improving the market system concomitantly with developments in production, and for moderate rather highly intensive changes in marketing systems.

IV. Improving the Latin American Livestock Industry

During the past few years governments and research institutions of several Latin American countries have increased emphasis on livestock development programs. This has led to considerable financial and technical assistance programs in many Latin American countries.

Recognizing that the livestock industry is important to all of North, Central and South America, this part of the report was written in an attempt to outline ways and means of improving the future of the livestock industries. Emphasis is placed on the production and utilization of pastures and other roughages by ruminant livestock.

A. Livestock Feeds and Feeding

Major world emphasis on cereal and oilseed production persists, relegating animal agriculture to a lesser role in contributing to world foodstuffs production. The quantities of available nutrients which cannot be utilized by humans are enormous and the potential production of such materials, particularly in Latin America, is beyond comprehension. There is growing awareness that products commonly destroyed, ignored or improperly used may serve as valuable nutrient sources for the ruminant.

1. Livestock Feeds

a. Forages and Other Roughages

Forages are of the utmost importance in livestock production. In the U. S., studies indicate that about 75 percent of the total nutrients consumed by beef cattle are supplied by forages (Acker, 1963). For most Latin American countries, the nutrients supplied by forages are certain to approach 95 to 100 percent of the total nutrient intake. There is a growing international awareness that

cereal grains, oil seed crops and other human edibles consumed by livestock, will be increasingly diverted from animal diets to direct human consumption. In the U. S. 23 percent of the total land area is cultivated and in Western Europe, 31 percent. Of the uncultivated land a very high percentage is productive from the standpoint of forages and other roughages. In Latin America, less than 5 percent of the land is cultivated. World wide, 10 to 11 percent of the land mass is cultivated. In many parts of Europe and most of North America, 70 to 80 percent of the land area is used for crop production. In Latin America, less than 40 percent is used for any type of crop production. This indicates the possibility of a large expansion in crop production by developing new lands or applying new technology and intensive agricultural production practices on land already in use (U.S.D.A., 1968).

(1) Production

Growth of livestock feeds particularly forages and other roughages, has to a large degree in Latin America remained in the hands of nature. Management practices inappropriately applied by man have decreased rather than increased livestock feed availability in Latin America, however, the decrease is not beyond restoration. The present urgency for improvement is prompted by the rapid human population growth. The 3 percent per year human population growth in Latin America is among the fastest in the world (Cunha, 1965). Awareness of population pressures, expanding development programs and an awareness of the improved crop production in many world areas provides an optimistic outlook for the potential development of Latin America. The concerted action of the people is nec-

essary for development.

When studying the types of plants that are responsible for the food production of the world it must be concluded that only a few native or unimproved varieties have contributed to any measurable degree. Nearly all have been improved through plant breeding practices. Although over 3,000 plant species have been used for food and over 300 are widely grown, about 15 improved varieties furnish 90 percent of the world's food (Thurston, 1969). New varieties able to withstand environmental stresses and produce more nutrients per land unit, are necessary to upgrade low producing range and pasture lands, particularly in tropical and sub-tropical climates. In Florida, several new grass varieties have been developed which resist various stunt virus stresses (S. C. Schank, 1971, Florida, personal communication). The success of hybrids, resistant strains, and high yielding varieties is well known in the U. S. The situation in the tropics may be more difficult, but the problem is not insurmountable. Agricultural research in tropical areas has been largely ignored. In 1966, the figures of the Food and Agricultural Organization (FAO) of the United Nations reported that sweet potatoes, yams, and cassava are ranked after rice and maize as important food sources in the tropics. The amount of scientific research available on these crops is very scarce. There has been a lack of research on crops with an apparent potential in tropical or sub-tropical areas. The same condition exists with forage crops.

Legumes, because of their ability to restore soil fertility (nitrogen fixation) and their superior nutritional attributes have become an important part of pasture and range forage throughout the world. Their use in Latin America is limited. Many legumes native to Latin America are non-palatable, low yielding or susceptible to stress conditions and are not believed to make a significant contribution toward livestock production.

Use of fertilizers is highly controversial in Latin America. The problem is not their need or possible growth reponse, but rather with the relative cost and return involved. In many cases fertilizer application demands a high degree of manufacturing technology. Technology and its application is very costly in most parts of Latin America. Under these conditions with a relatively low value product, the economics of fertilization remains doubtful. When these conditions change, namely reduced costs of fertilizer and/or increased value of livestock products, the use of fertilizers may become widespread.

While Argentina, Uruguay, and southern Brazil have developed much of their cropland potential, most of Latin America has vast areas of undeveloped land. Much of this land has crop producing potential. As an example of what might be done in many areas of Latin America, a commercially owned ranch in Nicaragua has cleared several thousand acres of jungle or rain forest. Two systems of land clearing were utilized. A mechanized system utilizing bulldozers virtually cleared

the land in one operation, followed by a single burning which left the land in fairly good condition for seeding to forages. One problem encountered with this system was an extreme disturbance of the top soil. The manual system (slash and burn) requires a large group of men using machetes, chain saws and axes to cut the abundant growth and takes two to three years to make the land ready for forage planting. During the first year the underbrush was cut, allowed to dry, and then burned. During the second year most of the large and intermediate sized trees and the underbrush regrowth was cut, allowed to dry for several months and burned. Forages were seeded to the lands in either the second or third year. One year following seeding, the lands were able to be used for grazing. The company owning the land believes the system is economically feasible and is continuing their land clearing operation by hand after four years of experience. The land yield in beef production has increased from almost nothing to 200 to 300 pounds of beef per acre. The development program has included fencing, fertilizing, building livestock handling facilities and introducing good quality beef cattle. Similar, but less extensive programs of land development, are highly possible in most areas of Latin America.

(2) Utilization

The efficiency for livestock in converting proteins from cereal grains and oil seed is often quoted as 10 to 25 percent respectively (Weiss, 1964 and Moore, et al., 1967). The low efficiency of protein conversion implies that feeding of

cereals and oil seeds to livestock to produce proteins for human food is a wasteful practice and that livestock compete directly with humans for proteins. However, other factors must be considered. Livestock are not exclusively grain consuming animals. Farm animals, particularly ruminants, have the ability to convert feeds other than cereals and oil seeds into proteins for human consumption. Other feeds commonly utilized include forages, by-products from the harvesting and processing of plant and animal products and non-protein nitrogen sources.

Forages are nutrient resources not consumed directly by humans. Forages make up a large portion of the diets of farm animals. About 70 percent of the protein of the average U. S. dairy cow is obtained from forages. An average beef steer obtains 60 percent of its protein from forages and the beef cattle industry as a whole obtains about 75 percent from forages (Moore et al., 1967 and Acker, 1963). The sheep obtains 80 to 90 percent of their protein from forages (Moore, et al., 1967). In other countries, particularly in Latin America, the percentage of forages in livestock rations is considerably higher. Forages are often grown on land which is submarginal or entirely unsuitable for producing other crops. Data presented earlier in this report verify this view.

Recent trends in countries using higher percentage of grains and less forages in livestock diets are sometimes interpreted as irreversible results of new technology. These trends have been used as evidence to support the idea that livestock are increasingly competing with humans for food. The interpretations

are incorrect. The reason for increased use of concentrates in livestock diets is because of the economic advantage which is dictated by the least cost ration concept. If the demand for grains for human food becomes great enough to raise beyond feasibility, the trend will be reversed. The importance of forages is expected to increase rather than decrease.

The ruminant animal is unique in that it is able to utilize high-fiber feeds with a minimal amount of protein and can use non-protein nitrogen sources. Ruminants can also harvest feeds under rough topography and extreme climatic conditions. The ruminant is destined to an increasingly important role as converter of poor quality feeds to high biological value protein for human consumption.

Common grazing systems for pasture utilization are: (1) continuous grazing, where pastures are stocked at one time of the year and the animals graze in a given field or area all season or year; (2) rotational grazing, where a reasonably long rest period is followed by a short grazing period, the number of fields used depending upon the mixture and regrowth rate of the forage being used; (3) strip grazing, with electric (or other type) fences used to ration the daily forage need to a herd; (4) green feeding, with the forage being harvested by a forage chopper and bunk fed to animals; (5) rotation-deferred grazing, where the pasture is divided into three or five units with grazing on at least one unit deferred each year until after the seed crop has matured. The next year a second area is deferred. By so treating a new unit each year,

the entire area is rested and allowed to reseed itself; (6) rest-rotation grazing, consists of resting one sub-unit (range or area), while grazing the other. Resting one sub-unit of pasture or range completely for the desired time, to allow establishment of seedlings. During this period livestock are forced to intensely graze the unresting areas, thereby grazing less palatable as well as palatable plants. Each of the sub-units are rotated so as to receive rest and intensive grazing at regular intervals.

In addition to good grazing systems, grasslands need constant application of improvement methods to insure maximum yields. One or more of the following methods may be employed. (1) Proper stocking rate, where the number of animals for a given unit of land is such that overgrazing or undergrazing does not result. (2) Animal distribution, which is reflected in more even utilization of the forages. Better distribution may be accomplished through fencing, herding, adequate watering places, salt or other supplement locations, trails for easier access and controlling livestock pests such as flies which cause animals to congregate and seek protection. (3) Reseeding practices, where improper management and overstocking have seriously reduced the quality and quantity of forage, some method of reseeding may be the only logical alternative. Where most of the desirable plants have been destroyed and the soils are suitable, reseeding or renovating is advocated. Pasture land improvement problems are often complicated by the extremely variable conditions that prevail.

Grazing systems that minimize extreme stress on the desirable forage plants usually lead to sustained quality and quantity conditions.

Harvesting and storage. Forage handling is complicated by the nature of the product. In Latin America, this situation is further complicated by the cost of mechanization which is almost essential for forage harvesting. However, because of the possibility of extreme nutritional stress conditions, which do periodically develop, it would be unwise to completely ignor harvesting and storage of livestock feeds. There are several methods of conserving feeds to meet emergency needs.

The first and probably most common method of conservation is hay making. Many of the forages, when cut at the proper time and harvested with suitable methods, make good quality hay. Hay can be harvested from forages during the lush growth period when feeds are often surplus. Hay making is often hindered in Latin America by the rainy weather that accompanies the best growth periods.

Forages are often satisfactory for silage making. Silages may be very useful as an emergency feed in many parts of Latin America. In Australia, forage surpluses have been harvested for silage and stored in underground silos for as long as 25 years without appreciable nutrient losses.

Another method, and possibly most feasible for Latin American conditions, is referred to as stockpiling. This method takes advantage of abundant growth, deferring grazing until nutrient shortages are encountered. During nutrient shortage

periods, livestock are permitted to graze the stockpiled areas. Because of plant maturity and climatic influences, often the composition of stockpiled forages is considerably less than in-season use. However, because of urgent needs and particularly low harvesting costs this is often feasible in Latin America. In a research project in Uruguay, compared with silage and hay making, stockpiling proved most economical (Christiansen, 1965).

b. Concentrates

Concentrates, as used in this report, are feeds with lesser amounts of fiber and relatively higher amounts of energy, protein, minerals or vitamins. Concentrate feeds are not likely to assume a major role (quantity wise) in the production of livestock, particularly ruminants, in Latin America (Raun, 1968; Thurston, 1969; Cox, 1966; Willis and Preston, 1970). Their importance, like harvested forage, may be very significant as nutrient sources for specific supplemental needs.

(1) Energy

Most of the cereal grains are grown in Latin America. Wheat, corn, oats, rice and sorghum have been extensively produced while rye and barley production is limited. Wheat, rice and corn are grown primarily as a source of human food as are most of the other cereal grains. The art of producing cereal grains is generally quite well understood in Latin America. The production of cereal grains will increase and with the anticipated demand for human food, perhaps their importance to the livestock industry lies in their by-products

such as stalks, hulls, cobs, straw, and pre- and post-crop grazing. By-products are discussed later in this report.

Molasses and the associated crops or by-products are likely the most important source of supplemental energy. Sugarcane, sugar beets, beet pulp, cane-stalks, beet tops and molasses are some of the livestock feeds produced as by-products of the sugar industry which represent significant contributions to livestock production in Latin America. The sugar industry is growing and is certain to have an optimistic future. Many of these by-products go unrecognized as nutrient sources and their optimum usage under local conditions remains to be defined, however, their value is unquestionable. Molasses is considered equal in energy to corn when making up not more than 50 percent of an otherwise balanced ration. In a project in Uruguay, when molasses was tank-fed and/or sprayed on the foliage of dry-rank forages, compared with the control, animal gains were significantly higher (Christiansen, 1965). Molasses is generally not expensive in Latin America.

(2) Protein

In many instances protein is the most important factor limiting production in Latin America, particularly in the tropics. Characteristically grass forages are relatively low in protein and this is particularly true with respect to grasses grown in tropical climates.

When ruminant livestock graze forages during the rapid growing season, their protein needs are usually satisfied.

However, during dry seasons or after forages have become more mature, protein requirements may fall far short of being supplied without supplementation. It is not uncommon for forages, grazed by livestock, to supply only about one half or less of the protein requirements. Plant origin protein rich feeds with significant use in Latin America are products from cotton, peanut, flax, soybean and some other legumes. Some of these products particularly the soy bean products are imported, and only small portions find their way into livestock feeds. Fish meal, slaughter plant by-products (meat, blood, bones, etc.) and some milk products are commonly available. Their price is usually relatively high and limits their use in beef or dairy cattle rations. Non-protein nitrogen sources are available and used to a considerable degree. Most important among these is urea. Although Latin American data on present levels of urea use are scarce it seems that urea has an important role as a livestock feed and crop fertilizer now and in the future.

(3) Minerals

Although little is known about the actual mineral needs of animals grazing forages in Latin America, indications are that serious problems exist. Forages are characteristically low in calcium. Soils in areas of high rainfall are characteristically low in phosphorus. Studies in Latin America seem to varify these trends. Of the major minerals, calcium and phosphorus are likely deficient or not present in the proper ratio. Other minerals may also be inadequate.

Of the trace minerals iron, copper, cobalt, zinc, iodine and manganese may be deficient in livestock diets. Even

though many minerals are often lacking in the available feeds, mineral supplementation is rarely practiced. The availability of minerals through mining or industry by-products is not common. However, it is very probable that mineral supplementation could be profitably developed.

(4) Additives

Feed additives and growth promoting drugs or other chemicals are not used in the beef cattle industry. Less than one percent of the livestock are produced where growth promoting substances (other than disease combating medicines) are used in Latin America. Many times growth response to drugs or other chemical administration is so profound that returns are much greater than the cost involved. Diethylstilbestrol (DES) has repeatedly shown growth reponse of 10 to 15 percent with a similar increase in feed efficiency. The costs are small relative to increased productivity.

c. By-products and Crop Residues

An area of livestock feeding often neglected is the use of by-products or other unusual feeds. In many parts of the world there are large amounts of by-product materials which can provide valuable energy and protein sources. Cereal grain production produces a large supply of corn stalks, cobs, straw and wheat and rice milling by-products. The slaughter industry provides blood, meat, bone scraps, and tankage. The citrus and sugar industries have pulp, bagasse and stalks. Oil seed industries produce meal, hulls and polishings. Other feed possibilities are cull bananas, coffee, cocoa pods, fresh sugar cane

and cassava. Starchy crops such as cassava and potatoes hardly enter into world trade. One reason is their high perishability. These foods are likely more important in the tropics than available information indicates. Crops which are generally disliked because of their carbohydrate and low protein content, are converted to protein when used as livestock feeds when supplemented with a non-protein nitrogen source. Yields of cassava in Brazil expressed in calories, are about three times those from corn and rice (Thurston, 1969). The use of by-products in livestock feeding certainly merits more consideration than given in the past.

2. Livestock Feeding

Feeding animals is perhaps the single most important activity with which the livestock producer is concerned. This is true because feed is the largest single expense item and also feeding requires the greatest amount of time in raising livestock. Feed usually accounts for more than half the total expense, thus the more one knows about feeds and feeding in relation to the kind of livestock raised, the greater will be his opportunities for improving the efficiency of livestock production. Selecting the correct feeds, using the right combinations of feeds, and many other similar practices are some ways which will enable livestock producers to feed more economically, increase efficiency, and make the most profit from their particular operation.

a. Diet Formulation

With regard to livestock diet formulation, one should always first pay particular attention to the basis of animal requirements, namely, energy, protein, minerals, vitamins, etc.

Second, one must consider the most abundant and least costly source to satisfy the basic requirements. The person must then decide on the feed or combination of feeds which most nearly meet the animal's requirements. If the nutrient requirements have not been satisfied in the basic feeds then supplements rich in the particular nutrient or nutrients low in the diet should be selected. In selecting supplements, energy, protein, minerals or vitamins, the most abundant and least costly source of nutrients should be used. Using these guidelines livestock requirements, particularly for ruminants, can usually be satisfied with locally grown and produced feeds. There are some exceptions under these conditions for which the livestock producer must go beyond locally grown and produced feeds to meet his needs.

(1) Livestock Requi[illegible]ts

Providing balanced diets for livestock need not be a complicated problem. A simple outlined procedure is advisable. First, the nutrient requirements for the particular type of livestock must be known. As an example, let us find the requirements for a cow weighing 400 kilograms. Referring to NRC nutrient requirements of beef cattle, we find the requirements to be 6.4 kg. of dry matter, 0.38 kg. of total protein, 0.18 kg. of digestible protein, 3.2 kg of TDN, etc. For ease of calculations these figures can be expressed as a percent of the ration. Dividing the requirement for total protein (0.38 kg.) by the total dry matter (6.4 kg) gives us about 6.0 percent. In the same manner digestible protein would be about 3.0 and TDN, 50.0 percent.

(2) Diet Ingredients

Compare these requirements with a common sub-tropical grass, bermudagrass. Bermudagrass contains 8.9% total protein and 4.8% digestible protein and 43.0% TDN. Protein is most critical for this type of livestock. It would be safe to assume the protein and energy requirements have been met. Further, similar calculations will show the relationship of needed minerals and vitamins as compared to those supplied by the feeds. In like manner, an over mature tropically grown grass may have only 4.0, and 2.0 percent total and digestible protein respectively and 50 percent TDN. In this situation, it is easy to see that protein is deficient even though TDN is adequate. A protein rich feed source should be added to the diet in an amount adequate to meet the protein requirement. It should be emphasized that increasing total animal feed intake increases both protein and energy and tends to correct diet deficiencies such as those discussed above. These are two examples of diet conditions common to Latin America. Admittedly, more complicated diet conditions exist and for their solution, a more extensive procedure must be used to balance nutrient requirements on a practical basis.

Regardless of the complexity of the situation, the basic principles should still be applied. First, outline livestock nutrient requirements. Second, attempt to supply these requirements with the proper combination of the most abundant and least costly local feeds. Third, to satisfy nutrient deficiencies, again select the most abundant and least costly

feeds or supplements which are rich in the deficient nutrients of the diet. One should not, however, ignor the importance of adequate animal feed intake. The procedures of balancing livestock rations need no extensive coverage in this report. Several methods of ration balancing are reported in the literature.

It would be well to emphasize the importance of applicable data for use in balancing livestock rations. For many areas of the world there are vast amounts of data regarding livestock requirements and the composition of feeds used in feeding programs. Both the requirements and the composition data are applicable since they have been determined specifically for the type of livestock and feeds commonly found in those areas. Similar conditions are not found in other areas of the world, particularly less developed countries. The livestock requirements are assumed to be about the same regardless of the type of climate or livestock in question. This assumption, though it may not be completely valid, provides workable guide lines. One cannot assume non-variability of feed composition due to type of plant or climatic conditions. For this reason, composition of feedstuffs as influenced by the type of feed and climate conditions is ranked with a higher priority status than determining livestock nutrient requirements. Composition of feedstuffs is covered later in this report.

b. Feed Composition

The chemical constituents of feedstuffs are referred to as feed composition. Many areas of the world, including Latin

America, do not have feed composition data in a collected or published form. Such information which would assist in diet, ration and feed mixture preparation is needed to replace the use of feed composition tables from other less applicable data, principally from temperate zones of the world.

(1) Proximate analysis

The proximate analysis is probably the most commonly used chemical method for describing feedstuffs. The feedstuff is divided into six fractions: water, ash, crude fiber, crude protein, ether extract, and nitrogen-free extract. These fractions are determined chemically, with the exception of nitrogen-free extract which is determined by difference. Proximate analysis is used as a descriptive device in establishing the characteristics of a feed and has been the key to determining the relative value of various feeds and their proper use in feeding. In applying proximate analysis to feeding problems one must recognize and consider the nature and limitations of the data as a description of the nutritional value of a feed.

(2) Biological Analysis

The proximate analysis serves as the basis for more specific analysis of given nutrients. The apparent digestion coeffiecents and the total digestible nutrients (TDN) are calculated from the proximate analysis of the feed consumed and of the feces excreted by animals consuming that feed. TDN has been widely used in the U. S. as a measure of the energy value of feeds, however, as man's knowledge of nutritional concepts and animal utilization has increased it has been

shown that TDN is not a reliable and consistent measure of the true energy value of a feed. In 1958, the NRC Committee on animal nutrition adopted the calorie system for evaluating the energy value of feeds to be used along with the TDN system. The calorie system uses gross energy, digestible energy, metabolizable energy, and net energy values of feeds or rations and for expressing nutrient requirements. In order to use the calorie system properly, the biological energy fraction must be partitioned correctly and adjusted for the energy losses in urine and feces arising from endogenous sources. The resulting values are then designated as the true energy fraction. The proper application of the calorie system allows us to specify energy requirements on the basis of energy for maintenance, energy for gain or energy for lactation (Crampton and Harris, 1969).

(3) Other Analyses

To adequately meet the nutrient requirements of animals, it is necessary also to know the mineral and vitamin content of the feeds. There are several possible methods of analyzing for minerals or vitamins with the chemical methods being the most common. Calcium and phosphorus are the most important minerals and vitamin A usually the vitamin of greatest concern. However, in many cases it is necessary also to know the content of other minerals and vitamins in a feed. Often the amino acid content of feeds for monogastric animals is required to achieve maximum feed efficiency.

B. Livestock Breeds and Breeding

Climatic conditions for livestock production in Latin America vary widely. They include the lush pastures and forage producing areas in intensive farming areas in the less tropical zones, the semi-arid grazing areas, such as parts of southern Argentina and northern Mexico, the low wet tropics and the high Andean areas. Under such variable conditions, each area has their own particular set of problems relating to the determination of the best adapted type or types of livestock to use. In many instances development of new types of animals adapted to the particular condition has been necessary.

1. Breeds

Breeds of animals currently available in Latin America are thought to be nearly sufficient for the development needs of the foreseeable future (Payne, 1970). Presently a wide range of breeds and types within breeds are used in Latin America. Sufficient numbers of breeding animals are generally available in Latin America. An increase of about 50 percent in total animal population should be sufficient to insure that the desired level of productivity is attained.

a. Native

Native livestock (Criollo) are those arising from animals having been in Latin America for several generations. They are not usually characterized by uniformity of size, color or conformation. They are sometimes referred to as non-descript animals. Even though they are not noted for their popular appeal and ability to place in livestock shows, they do possess some valuable attributes for tropical and sub-tropical climates. They have adapted to the conditions so they are less susceptable to

diseases and parasites as well as the extremes in climate. Most of the present cattle have a considerable amount of Brahman or Indu-Brazilian blood (Payne, 1970). To improve these cattle, from the standpoint of being economical, the application of good selection practices must be emphasized. Experience in all parts of the world have demonstrated the possible progress when good selection practices have been applied within a breed or a type of livestock. Crossbreeding and the introduction of new genetic stock can also improve animals, but these practices are costly and in many cases not practicable. Crossbreeding and introduction of new genetic stock is covered later in this report.

The selection practices recommended include setting up standards that animals must meet to qualify for use as breeding livestock. Important among these standards are (1) weight for a given age, usually the first 6 to 10 months of age; (2) type, in this case beef type; (3) fertility, as measured by pregnancy testing or by calving percentage; (4) productivity, indicated by calf weaning weights and an accumulative total number of calves and weight of calves produced; and (5) physical defects, such as bad feet and legs, udder problems, eye sight, etc. It is realized that if a high level of these standards is applied immediately most livestock operations in Latin America would rid themselves of the majority of their animals. It must be emphasized that the standards should be set in accordance with the potentials of the group of livestock for each particular operation. For example, it is completely feasible for a livestock manager to develop his standards based upon the percentage attainment of the animals in

question. He could decide that as a weight standard, the lower 35 percent will be culled and as a type standard, the lower 25 percent will be culled and so on until all of the standards have been applied in selecting his replacement breeding animals. In like manner, a manager may decide that weight at a given age is more important than type. In this case, an index system works well. Those standards considered are assigned an index number reflecting the degree of importance. The more important standards are given higher numbers and the less important standards are given lower numbers. When the index score is totalled, animals with the higher scores are selected. The level at which culling is applied must be determined for each individual operation and it may even vary from year to year. The principle can be applied in any level of production for almost any degree of specialization, pure-breeding, up-grading, etc. An improvement system similar to this or based on other effective methods, is particularly important for the native cattle operations. By far the majority of cattle in Latin America are the native stock and thus they should serve as the base for improving the livestock industry. The system also works well when applied to intensive livestock operations.

b. Introduced

The importance of native cattle has been emphasized and this report will not, in any way, de-emphasize their importance. This is not to imply, however, that introduction of new genetic stock should not have a place in the improvement of livestock production in Latin America. New breeds and strains within breeds are

continually being introduced. When properly handled they can contribute a great deal toward development of the industry. Because of their cost, adaptability, limitations and inconvenience of importation, their impact on the Latin American livestock industry should not be over emphasized.

When high quality animals are introduced, certain procedures are recommended. First, if possible, animals should be imported at an early age; second, stress conditions resulting from the environment should be reduced to a minimum; third, exposure to known problem diseases and parasites should be prevented, if possible; fourth, in the case of bulls, their mating work load should be reduced until they have adapted; fifth, a minimum amount of new genetic stock should be infused during the first generations; sixth, the nutritional and sanitational conditions the animal and its ancestors are accustomed to should be met as nearly as possible; seventh, and possibly the most important, sound selection practices should be applied. If a livestock operator can afford to import livestock and if he applies the foregoing principles, introduced genetic stock can have a pronounced influence upon productivity. A great deal of the contributions of imported animals results from hybridization or the heterosis principle in breeding animals.

c. Improved

A great deal has already been written about improved livestock in this report. Regardless of whether or not animals are native or introduced, the goal should be towards improvement. A classic example of this subject is the story of livestock in

the U. S. During the 1800's (and earlier) most of the livestock of high quality existed in areas of the world outside the U. S. principally in Great Britain or in other parts of western Europe. In the 1900's, however, through improvement practices, the U. S. unquestionably has some of the best quality livestock of any country in the world. There are exceptions, some people say the French Charolais and the Scottish Angus are superior. However, in general, the point is valid. The point of emphasis is that the U. S. livestock population quality is unsurpassed as a result of improvement practices applied to existing genetic stock. The same kind of improvement practices applied in Latin America can produce similar results in improved livestock quality. Emphasis should be placed upon the simplicity and inexpensive approach of setting up selection standards for livestock improvement.

2. Breeding Practices

There are many practices that fall into the category of breeding For this report, they will be handled in five major categories. a) Production testing; b) Pregnancy testing; c) artificial insemination; d) controlled estrous and e) seasonal calving. Other practices involved in livestock breeding are covered either within the five listed categories or in other parts of the report.

a. Production Testing

Performance testing is the practice of evaluating and selecting animals on the basis of their individual merit or performance. Progeny testing is the practice of selecting animals on the basis of the merit of their progeny. Production testing is a more inclusive term, including progeny testing and/or performance testing (Cole, 1966). Production testing is not new; it has been advocated

for hundreds of years. It was effectively used by Robert Bakewell, in England, in the eighteenth century in his bull and ram selection program.

An important aspect of production testing is employing a management system which reflects the production potential of an animal, early in its life, such that culling or selection lead to improvement of the offspring. For meat producing animals the "yardsticks" or criterion of potential improvement are not easily determined. Extensive studies have been made of the factors which should be evaluated in breeding meat animals. The relative importance of each character to be considered varies under different conditions.

Regardless of the conditions, species of animal or environment, a prerequisite for any testing program is positive animal identification. This is discussed in another part of the report. Weight for age records are also essential to any system. Body-type and conformation scores should be part of the record. They should be taken at a standard weight or a standard age (weaning time and annually thereafter), being evaluated in terms of either a numerical score or a letter index. It is important that all animals be evaluated and their scores made a part of the record. The records should be simple and in a form that will permit easy summarization. One good way is to maintain the record of each individual animal on one sheet. Information on the productivity of close relatives (sires and dam and the brothers and sisters) can supplement the records of the animal itself as an aid in selection. In most livestock, the influence of more distant relatives is of little importance.

Under many practical conditions, testing with meat animals is often confined to the sire. This is because the sire produces many more offspring than the female, offering more facts for selection. Female testing, even though more difficult should not be ignored. As more efficient production levels are desired a producer should utilize the potential of the dam side of his livestock. This is particularly true of the dams of potential sires. It should be pointed out that progressive livestock breeders should be using sires backed by good records. This practice should also apply to female animals as much as possible. Production testing is an effective tool for selection, and should be used together with individual pedigree and show-ring performance rather than to replace them.

b. Pregnancy Testing

Pregnancy testing has become an important tool in culling low producing animals because it has the advantage of early diagnosis of pregnancy. Before production and maintenance costs are encountered the non-pregnant animal can be sold or placed under an intended sales program. The pregnancy test referred to in this report is the rectal method and not the usual absence of heat or other less dependable signs of pregnancy. The rectal method is relatively simple and an experienced technician can consistantly diagnose pregnancy as early as 60 days following conception. More positive results can be achieved by 90 to 120 days after mating. Pregnancy testing is becoming standard procedure in the U. S., with many producers conducting the tests themselves. It should be applied in Latin American livestock

operations.

c. Artificial Insemination

By definition, artificial insemination is the deposition of male sperm in the female genitalia by artificial rather than by natural mating. The practice of artificial insemination had its beginnings hundreds of years ago, but has not had any real impact upon the world livestock industries until the mid 1900's. In the past 30 years, artificial insemination has become commonplace in the U. S. Artificial insemination offers some extremely important advantages for less developed countries. First, the cost is significantly less than importing live animals. Sperm from proven sires can be purchased in almost any country in the world. With a moderate amount of training technicians can achieve conception rates equal to or better than natural mating under most conditions. Second, the problems of importing and exporting live animals is somewhat problematic while sperm importation is already a common practice in most countries. Semen banks are located in most livestock producing areas in Latin America. Third, the adaptation problems for animals are less pronounced. The fetus undoubtedly acquires some resistant attributes from the mother during gestation and lactation. Artificial insemination with its bank of excellent quality genetic material of almost any breed, definitely should be practiced, wherever possible, in Latin America.

d. Controlled Estrous

Controlled estrous is the practice of manipulating endocrine functions so that an animal's heat period can be predetermined.

This practice is still in the experimental stages. Presently, it would not be sound judgement to recommend its practice, on a widespread basis in less developed countries. However, if it develops to the extent of its "talked about" possibilities, it could very well be applied in the Latin American livestock industries. Coupled with artificial insemination controlled estrous could contribute toward a giant step forward for quality livestock and improved livestock production in Latin America.

e. Seasonal Calving

In many parts of Latin America calving is a yearround program. In some conditions this may be the most desirable practice to follow. In the majority of situations, however, better overall success is experienced when following a definite seasonal calving practice. The decision depends upon facilities available, feed supply, pasture growth patterns, labor and weather conditions. In Latin America, the most important factors are the feed supplies and pasture growth patterns, and weather to a lesser extent. Assuming that weather is not a major factor, it is generally recommended that calving be planned so that both calves and cows are able to take advantage of good feed supplied particularly during mid-lactation. This provides for fast growth of the calves so that at weaning time they are developed adequately to continue without their mother's milk. This procedure also meets the increased needs of the cow during her maximum milk production period. In addition it provides desirable nutritional conditions for the breeding season.

In some areas of Latin America there are at least two periods

of the year where feed supplies are usually high. Under these conditions, two calving seasons per year could be successfully practiced. This would permit a wider use of sires in that they could be used on different groups of cows at two different times of the year. It may also afford a better distribution of livestock to take advantage of both feed conditions and marketing of slaughter animals. It should be emphasized that conditions vary widely and that seasonal calving patterns should fit into the overall situation to take advantage of the factors contributing most towards improving livestock production for the given circumstances.

C. Livestock Management Practices

Management, as is used in this report, does not apply to feeds and feeding, breeds and breeding and forage production and utilization. These subjects are covered separately. Management as used in the context of this report is concerned with records, land, capital improvements, livestock identification, flushing, weaning, dehorning, castration, spraying and dipping, etc.

1. Record Keeping

In agriculture today, the complexities of the industry have placed it in the category of a business, a business which should be conducted in a businesslike manner. One might ask the question, why keep records? Some of the reasons are; 1) provide information from which the enterprise may be analyzed thus leading toward the decision making process; 2) Provide a record of the financial status of the operation; 3) to show production records on livestock and crops; 4) to aid in obtaining credit when needed.

a. Kind of records

For application under Latin American conditions, record keeping systems may need to be adapted as influenced by local custom, production practices and language differences. However, the basic principals of good records do apply to good livestock production regardless of the country. There are many different types of records that are satisfactory. An adequate system may be devised by any producer. It seems important that records should show as much information as is required to satisfy the objectives as listed above. Additional information may be no value. Three parts that should be included in any record keeping system are: 1) Inventory section; 2) Receipts and expenses section; 3) Livestock and crop production section. (Acker, 1963 and Ensminger, 1969).

b. Summarizing and Analyzing Records

With adequate information available, in order to make full use of it, proper summarizing and analyzing is necessary. The analyzed record should show ways to improve the production and economic conditions of the enterprise. In some cases specialized assistance may be required to get the most from a good record system. A good record system should have indicators, easily recognized, which lead to more profitable or efficient decisions (Cole, 1966).

2. Land and Capital Improvements

In most livestock enterprises land and other capital items are essential to production. This is universally understood. Other factors less well understood may be: 1) Quantity of land; 2) Type

of land; 3) Kind of buildings and other facilities; 4) Need for machinery; 5) fencing. The producer then is faced with the task of fitting together, in proper combinations, livestock units, land areas, land use, buildings, equipment and other facilities which will lead to the greatest returns relative to investment and other cost factors (Christiansen, 1964).

a. Land/Animal Unit Ratio

One of the first decisions in a livestock business is to determine the size of the enterprise. Then if a given value of product is to be marketed yearly, a given number of animals is required to meet the desired production level and a given amount of land (within seasonal and other variation causes). In Latin America, Livestock production operations are usually very large or very small. In many instances, little consideration has been given to economic size of the enterprise. Very little attention has been given to the relationship of number of animal units and the amount of land required. These conditions have led to overstocking or understocking of pasture lands.

b. Fencing

It is generally agreed that land partitioned by fences that provide a means of controlling its use due to season, crop, type of livestock, etc. can be managed so that more total product will be realized than if the land was grazed continually as a total package. This agreement can be supported by several examples: 1) establishing a new crop; 2) renovating an old pasture; 3) providing a plant rest period; 4) deferred grazing; 5) rotation of grazing; 6) separating age and class of livestock; 7) proper water

use, (stock or irrigation).

c. Buildings and Other Facilities

Some years ago cattle and sheep may have been produced by an enterprise that had no more than a place to tie or corral a few head of animals. In today's agriculture, it would be difficult to justify a livestock enterprise without some buildings and other facilities. The situation definitely applies to Latin America. Sick animals must be cared for, branding, dipping, or spraying, separating livestock (cows and calves, steers and heifers, bulls and cows, etc.); machinery storage, feed storage and feeding supplements on the range or in pens, are a few examples showing the need for some buildings for handling of livestock and storage of equipment and supplies. Livestock producers should be equipped with adequate tools and supplies to restrain animals, dehorn, castrate, spray and take care of other routine tasks which continually need to be accomplished.

3. Livestock Identifcation

Proper livestock identification, regardless of world area, is essential to a good record keeping system as discussed earlier. Without some means of animal identification, no record can be kept to show performance, reproduction or other production guide lines (Ensminger, 1969). Several methods for identification are presented.

a. Tagging

Ear tags, neck chain tags and other types of tags are included in this section. There are several types of ear tags, although metal and plastic are the most common. They are easily installed,

but are subject to being lost by rubbing or catching on fences or other obstacles. Tags are available that can be read from a distance of several feet. Tags not only show owner identification but also individual animal identification. The kind of equipment and materials should depend upon the availability and common usage within each country.

b. Marking

Ear marks, buds, wattles, and dewlaps are common means of animal identification. Each of these methods can be used to show animal ownership, but only the earmark offers good use as an individual animal identification method. The earmark is easily administered, is permanent and is also easily recognized. Ear notches, used in a specific manner, provide individual animal identification. To establish ownership these marks must be recorded by country, state, city, etc. The systems and procedures followed should be adapted to the situation of the country involved.

c. Branding

Hide brands and horn brands are common methods of livestock identification. These methods can be used to establish ownership or for individual animal identification. The hide brand, when properly applied, is permanent, easily applied, recognizable and is thought of as the livestockman's trademark. As with marks, to establish ownership, it must be publicly recorded. Brands are placed on almost any small flat surface of the body. Common locations are on the cheek, ribs, thigh, rump and shoulder. Brands are applied with hot irons, chemicals or cold branding. The first

two methods result in killing the hair while the third (freeze branding) kills the hair pigment which leaves a white hair color. It works successfully on animals with dark hair coats.

Paint brands are used on some classes of livestock, principally sheep. Lead-base or tar paints have good staying properties and are commonly used in making number or letter brands. Brands are presently commonly used in Latin America.

d. The Tattoo

In horses, registered cattle and some other types of livestock, tattoos are used for identification. Tattoos work best on light skin, often being placed in the ear or under the lip. On dark skinned animals, tattoos are difficult to read.

4. Other Management Practices

a. Flushing and Creep Feeding

Flushing is the practice of feeding cows, ewes, sows, etc. more liberally than usual for 5 to 8 weeks prior to the breeding season. The purpose of flushing is to increase conception rate through enhancing estrous conditions. Flushing may be accomplished by grain feeding or grazing good lush pasture or range. Calving percentage and lamb crops are improved sizeably through flushing (Cole, 1966).

Creep feeding is the practice of feeding concentrates or other nutritious feeds to young animals. It should be done so as to insure that the young animals actually get the feed, usually by providing a separate enclosure so that older animals cannot enter. Creep feeding and flushing are practices not commonly used in Latin America. With proper forage utilization they could easily

be applied with beneficial results.

b. Early or Late Weaning

Early or late weaning refers to the practice of weaning animals earlier or later than usual. Several conditions may justify this practice. If feed conditions are such that the nursing mothers are under extreme nutritional stress, early weaning may be advisable. If feed conditions are unusually good or if the young animals can take advantage of a situation of good strong and high producing mothers, then late weaning may be best (Christiansen, 1965). It is not uncommon in Latin America for calves to nurse until 10-12 months of age. Under these conditions, the cows usually calve only every other year.

c. Dehorning, Castration and Docking

There are a number of common methods of dehorning, castration, and docking farm animals. The main things that should be stressed is to do it when the animals are very young and under sanitary conditions. Usually from a few days to a few weeks of age is best (Ensminger, 1969).

d. Spraying and Dipping

Animal insects and pests are responsible for large losses every year. Their control and eradication are usually accomplished through spraying and dipping livestock with the appropriate chemical. Flies, lice, ticks, mites and other insects can easily be controlled with proper dipping or spraying programs. Because of the losses in Latin America due to insects, these practices are very applicable for the improvement of livestock production.

D. Controlling Diseases and Parasites

Producers of livestock must realize that many livestock diseases are extremely detrimental to production efficiency, Diseases are transmitted between classes of animals and from animals to man. It is noteworthy, for example, that over 90 different types of infectious and parasite diseases can spread from animals to human beings. Parasites or diseases are not usually present in the animal at birth but are acquired later. Diseases are usually acquired through the introduction of diseased or unhealthy animals or improper sanitation, feeding, care and management. In the U. S., about 15 to 20% more livestock product could be realized through effective control of diseases and parasites. Estimates for Latin America indicate that production could be improved by as much as 40 to 50% through proper control of diseases and parasites (Phillips, 1956 and Payne, 1970).

1. Foot-and-Mouth Disease

Foot-and-Mouth disease (FMD) has become one of the most dreaded of the animal diseases. It is also known as aftosa in Latin America where it is widespread and is a constant problem for livestock producers. Because of widespread movement of livestock, livestock products, human and vehicles, FMD is a constant threat to livestock producers throughout the world. Although previously infested with FMD, many countries have had successful eradication programs. Although mortality from FMD has reached 50% in some cases, the most serious losses are due to abortion, mastitis, sterility and reduced growth and milk production (U.S.D.A., 1956).

In Argentina, progress has been made in the control of FMD. Although eradication has not been possible fairly effective control

measures are used. Vaccination against FMD is not compulsary but is a normal practice and has proven effective as a preventive measure. In Argentina, vaccination should be carried out every four months to maintain a satisfactory level of immunity (Phillips, 1956). Panama, El Salvador, Nicaragua, Costa Rica, Honduras, Guatemala, Mexico, Guyana, Surinam, Jamaica, Trinidad and Puerto Rico are free of FMD, but constantly fear an outbreak. Most countries have plans and facilities to deal with an outbreak, but others have neither plans nor facilities.

2. Other Livestock Diseases

a. Brucellosis

Brucellosis is an abortion disease which causes heavy losses in cattle, sheep, swine, goats and man and is present wherever livestock are found. Through vaccination of young animals, slaughter of infected animals and obtaining replacement animals free of the disease fair control and prevention are achieved. Extensive procedures have been developed for eradication. For these plans to be effective Federal policy and regulation are required and are carried out through controlled veterinary programs (USDA, 1956).

There are many other diseases which are costly to livestock production. Some of the more common diseases are: anaplasmosis, peroplasmosis, tuberculosis, mastitis, cholera, blackleg, leptospirasis, vibriosis, shipping fever, tick fever, pink eye, tetanus, etc. The importance of controlling or eradicating these diseases should not be overlooked. However, this report does not cover each of them in detail since control or eradication practices are

similar to those discussed for FMD and Brucellosis.

3. Parasites

The economic effect of parasites is not confined to losses by death of infested animals, but is largely concerned with lowering of normal production of animal products, including milk, meat, wool and reproduction. Losses are difficult to accurately access, but it is agreed that they are extremely high in most countries, particularly in Latin America.

Use of modern medicines, drugs and other chemicals have proven to be very effective. However, there are some parasites for which there is not adequate control treatment and further research is needed. The practice of improved methods of livestock management, together with emphasis on supplying adequate minerals and vitamins, have proven beneficial in reducing losses from parasites. There remains much to be learned about the total influence of nutrition on parasitic infestations.

The important parasites are: liver flukes, tape worms, ticks, flies, screw-worms, fleeceworms, mosquitoes, grubs, lung worms, etc. Losses from parasites occur not only from the parasitic influence, but also from their disease transmitting potential. In planning control measures to be used in a country for the control of parasites, due regard should be given to climatic conditions which may influence the life cycle of the parasite. For example, climate may determine the interval between the applications of insecticides for control of some ecto-parasites (USDA, 1956).

E. The Economic Factors

The present role of livestock in Latin American agriculture has already been discussed. Likewise, potential increases in production and contribution to development have been outlined. Economic growth in livestock industries is interrelated with growth of the whole agricultural sector and with expansion in nonagricultural sectors of Latin American economies. Governments of many Latin American countries have initiated livestock industry development programs to help diversify agriculture, improve farm incomes, gain foreign exchange, and increase domestic protein consumption. Additionally, growing consumer incomes due to overall development efforts result in expanding markets for meat and livestock products. Livestock and other agricultural industries depend on the nonagricultural sector for capital inputs to apply improved technology.

This section discusses the economic factors important in Latin American livestock industry improvement. As in previous sections, beef will receive most emphasis. The discussion will be divided into sections dealing with the economics of production, marketing, consumer demand and trade. The final portions will cover government policies affecting industry improvement and point out some research needs that must be met before significant improvement can occur.

Even though the following discussion is divided into sections dealing with production, marketing and so on, the general approach is one of viewing a livestock industry as an interrelated system or subsector. Modernization of production depends on price and income incentives generated by domestic and export demand, and marketing changes may result from production and demand influences. The effects

of government policies and development programs on the entire subsector must be considered.

1. Production Problems

Livestock production problems and the reasons for low productivity have been pointed out in some detail previously. These problems affecting beef cattle production are restated briefly as prelude to discussing development possibilities.

Beef cattle production problems

a. Lack of pasture management

(1) Overgrazing

(2) Inadequate forage during dry seasons

b. Nutritional deficiencies

(1) Cattle limited to diets of native pasture and salt, with no protein supplement or improved pasture.

(2) Nutritional deficiencies help produce high mortality rates, late sexual maturity, and weight loss during dry seasons, resulting in long periods, up to five years, required for animals to reach market weights.

c. Low reproductive rates

(1) No breeding records, inability to distinguish between productive and unproductive cows and bulls.

(2) Low culling rates and retention of poor breeders in herds.

(3) Uncontrolled breeding, with calves born throughout the year.

d. High mortality rates and weight loss

(1) Death loss and poor performance due to inadequate disease control and health care.

(2) Calf losses due to drowning in rainy seasons, lack of forage in dry seasons, and theft.

e. Lack of adequate fencing, corrals and barns, watering facilities, equipment and other items necessary in herd and pasture management.

f. Uneconomic behavior by ranch owners

(1) Ranch ownership as status symbol, inflation hedge, or continuing family tradition, with little dependence on ranch return for income.

(2) Little concern with insuring competent management or employees.

g. External and institutional factors

(1) Lack of all-weather roads, hampering livestock marketing and input distribution.

(2) Lack of adequate credit amounts and arrangements.

(3) Inadequate or ineffective technical assistance from extension services and research agencies.

(4) Deficiencies in the market system.

This listing of problems can be summarized by saying that no really adequate and viable beef production system has been widely applied in tropical Latin American countries.

The existence of a few well-managed productive beef cattle enterprises in every tropical Latin American country exemplifies the potential for improvement while emphasizing the great difference between the requirements for a modern system and that prevailing generally. Existing successful operations and research findings help identify some essential elememts in overcoming the problems listed and achieving needed increases in output and productivity.

Additional investment and a higher level of management are requisites. All inputs must be combined properly into a logical production system. The external environment of transportation, communication, markets and government services must be reasonably favorable. This latter requirement means that livestock development programs will have much greater chance of success in regions where these external elements do not present major obstacles. With

two regions comparably endowed with resources and production possibilities, but one remote and lacking access to markets, inputs, and services, the more favorably situated region will be more likely to show production increases, productivity improvement, and a greater payoff for development effort.

Given this reasonably favorable environment, beef production systems resulting in larger output per unit of input and more favorable return on investment than prevailing systems are those with moderately intensive use of additional inputs. The basic product, a grass-finished steer or bull, reaches market somewhat sooner and moderately heavier than from traditional operations, but is not drastically different.

Some recent studies (Dow, 1971 and Mullenax, 1969) compared beef brood cow enterprises using extensive management, moderately intensive systems, and intensive operations. Extensive systems used minimum inputs and were typical of brood cow operations in the plains or llanos areas of many tropical Latin American countries. Medium-intensive systems used some improved pasture, with a higher level of management and better husbandry practices. The most intensive systems required substantial investment in pasture improvement, facilities and breeding animals.

The specific technical coefficients or financial items included in these production systems are not as important as the broad indications that can be derived. Of the three types of brood cow enterprises, typical extensive systems showed a very low return on investment, and the most intensive system showed losses. Moderately improved enterprises exhibited the greatest return, but were still below the prevailing rate of interest. Such a rate of

return, compared with available alternatives, helps explain the lack of private investment to modernize brood cow operations.

Conclusions from this study and others similar (Mathis et al., 67-2) also point to factors important in livestock development programs. In some cases even the most profitable brood cow systems would require capital subsidies of more than 50 percent of required investment at current beef prices, or prices would have to increase as much as 40 percent, for the owner to realize a reasonable return on his capital. Additionally, the most intensive systems exhibited negative returns, even with assumed price increases up to 50 percent. However, traditional brood cow systems studied, typical of most operations, now would require even greater price increase to achieve an adequate return on investment. While reliable data from similar operations under a wide range of conditions are not available from many countries, the few studies useful indicate the same general conclusions.

Brood cow enterprises in tropical areas are not highly profitable and economic incentives to modernize are not sufficiently strong. Low rates of return from traditional beef cattle ranches indicate that owners are not interested in return on fixed investment, but only in recovering actual cash expenses. If it was deemed desirable for these operations to modernize and increase beef production, other than economic incentives would be necessary.

In countries where rates of return to beef production are below current interest rates, producers could transfer their resources and be better off. However, continued beef enterprise operation in these countries, even with low productivity, implies that con-

sumers are being subsidized at the expense of these producers, given present conditons. Nevertheless, the primary need remains one of increasing the total product from the livestock sector as well as allocating a given output efficiently.

2. Marketing and Demand

The characteristics of traditional marketing systems mirror to a large extent those of the producers whose output they distribute. Both groups are characterized by a low level of output and technical efficiency, limited capital resources, an absence of standardization and inadequate facilities (Mayer, 1965). In a poor economy, with a relative scarcity of goods, markets are generally stable. Selling is simple, and consumers make do with the limited quantities--and often poor qualities--of products offered.

The complementarity of production and its supporting marketing-distribution sub-system becomes obvious. Changing marketing firms through added capital, different institutions or greater scale of operations cannot transform either supply or market conditions. Suppliers, distributors and consumers must transform themselves in tandem. Several investigators have concluded that it is fruitless to induce development in the productive sector without insuring that complementary advances are made in the distributive sector (Mayer, 1965).

Marketing is taken to mean all the facilities and activities associated with the exchange of goods and services, either for consumption or for further use in production (Mehren, 1959). Thus, this exchange process is important in Latin American livestock industries both for sale and distribution of livestock and meat and

of inputs required in the production process. The influence of improved marketing can be emphasized by stating that agricultural producers are concerned with the terms of trade between the commodities they produce and the commodities they purchase and not just with the prices of what they sell (Mellor, 1966).

Both production and marketing of livestock and livestock products seem less amenable to rapid improvement through application of modern technology than do many crops and their products. Animal production and biologic processes are more complex and longer term. Resources necessary to identify and induce change are greater. The relatively minor role livestock have played in most tropical countries has helped to foster neglect. Low meat consumption in tropical Latin American nations has prevented much demand impact on production or marketing, and little is known of consumer desires relative to livestock products.

Recent studies project domestic meat consumption to increase at a rate proportional to population growth and income increases. In Central America, for example, demand conditions for beef were jedged favorable in a recent study (Battell, 1969). Export potential to the U. S. was expected to be the major stimulus for greater beef production, even though domestic demand was projected to grow, also.

Many studies and projection, however, lay stress on the lack of knowledge concerning important demand factors. Meat, and beef in particular, is income-elastic, but the degree of response to change in consumer incomes has been estimated in few Latin American countries. Likewise, price elasticity of demand is unestimated

for different population and income groups in most nations. Reasonably accurate and reliable estimates of these measures would allow informed projections of likely quantities of meats required for domestic consumption. Demand estimates for different regions and income groups can be used in guiding modernization in specific areas of production and marketing. The impact of income increases resulting from overall development programs on the livestock industries can be estimated if usable data are available.

Conclusions regarding factors required in marketing system improvement are less clear than for the production sector. The lack of demand studies just mentioned and the scarcity of marketing research previously described make identification of development strategies more difficult. A few research efforts are useful in this respect.

Two studies of food marketing in Puerto Rico (Galbraith, 1954 adn Wuhrman, 1966) allow some tentative conclusions regarding meat marketing and demand. The food marketing system in Puerto Rico of two decades ago was similar in many respects to that of most Latin American countries then and now. The first economic studies involved a model food system, composed of the optimal retail unit, the wholesale unit, and an estimate of the saving that could result if the food system was rationalized. Specific policy measures to improve marketing efficiency were suggested (Galbraith, 1954).

From the research efforts and policy actions, a modern, efficient food marketing system was developed in Puerto Rico. Most recent research found that the size and scale for marketing firms had increased, and the food industry had increased the number of work-

ers it employed. Production and marketing costs for fresh eggs and milk had been reduced, and product quality improved significantly. While not determining specific causality, the research indicated that marketing performance changes accompanied government market programs and private marketing developments. Additionally, excessive numbers of small marketing firms were found to hamper productivity improvement and inhibit agricultural and marketing development (Wuhrman, 1966). Other studies confirm the need for improving the market system concomitantly with developments in production, and for moderate rather than highly intensive changes in marketing systems.

3. Trade

The present status of livestock and meat trade in Latin America was discussed earlier. Trends identified there seem likely to continue in the foreseeable future. The higher-income countries in the region will likely continue importing substantial shares of their meat supplies, mostly beef, from other Latin American nations. Beef production in these countries could increase if economic conditions continued favorable, but income growth will likely provide a continuing spur to imports.

Those countries currently exporting at the expense of domestic production will probably reduce those exports in the future, and some could become net importers. The number of beef-exporting nations in Latin America will probably be reduced to the traditional exporters, Argentina and Uruguay, and a few other countries with greater potential for expanded beef production. Rapid population growth in all countries and income improvement in some will absorb

larger and larger quantities of beef and other meats. Pork is not likely to be traded within Latin America to any degree, nor will lamb and mutton.

The United States will continue to be a sizable market for manufacturing beef from Latin American exporters, as long as U. S. consumer incomes continue increasing and U. S. supplies do not increase more rapidly than seems likely now. However, U. S. imports will continue to be subject to quantity limitations as well as sanitary regulations, which will keep a ceiling on Latin American beef shipments.

Government policies, therefore, will largely determine what impact trade has on livestock industry development. U. S. policies and those of the Latin American governments must be considered.

4. Policy

As previously noted, most livestock development programs in Latin American countries have concentrated on supplying financing for capital improvements and improved breeding stock. A few nations have a coordinated program of technical assistance in production, including research and extension efforts and needed modern inputs. Some of these same few have policies regarding domestic and export prices and quantities that act as incentives for production improvement and increase.

Previous advances in crop production in several developing countries can provide guidelines for livestock industry improvement. In spite of the added complexities of livestock production, the promise of improvement is evident in certain instances.

Improvement of agricultural marketing in developing countries,

however, has been and will continue to be extremely difficult. One analysis cites the differences between modernizing the production sector and improving a market system:

> Successful (production improvement) programs have had few and simple targets; used few and simple target determinants as operational bases; depended mainly upon incentive and assurance to generate activity; and availed of special demonstration techniques. Users were persuaded that complete, secure and profitable technologies were available. Income uncertainities were diminished. Can this kind of programming be used in design and execution of market activity? Nearly all assistance activity has been unprogrammed. Total country programming may be impossible. It probably is not necessary. What are the determinants of successful program design and execution? What constraints limit adaptation of successful programs to other purpose or places? (Mehren, 1959, pp. 3-4).

The same paper concludes:

> First, as economies turn to commercial marketing, new public-private relations must be forged. There is little analytical basis for formulating new relations. Second, both in government and business, there is very little available analysis relevant to operational decisions. There is far less operational competence than is found elsewhere. There is little real entrepreneur-government colloquy... Standard management practices have not yet penetrated many nations perhaps especially in marketing. Status and role of government as known here is almost universally absent. Attitudes of distributive trades differ sharply from those in older commercial economies. (Mehren, 1959, p. 15).

E

Economic integration throughout Latin America will have significant effects on each nation's policies toward their own livestock industries.

Certain countries in the region can expect to export to other higher-income Latin American nations, but the tropical countries as a whole will likely exhibit deficits in both beef and pork in the next few years (Florida, 1970). Thus, continued easing of trade barriers will be beneficial to a few exporting countries, but

most of the other nations must look to increased domestic production to meet their consumption requirements in the near term. If production lags, then little can be expected from the total livestock system.

5. Research Needs

Research can specify the means for attaining development targets, however, products must actually be produced and marketed if measured potentials are to be achieved. Major attributes of government programs may be identified analytically, but identification and administration are quite different (Mehren, 1970). Accordingly, two sets of questions can be formulated in regard to research needed for Latin American livestock industry improvement.

First, what are the important but unanswered analytical questions of production, marketing and trade? Second, what sanctions, incentives and assurances will generate the needed but unavailable activities requisite to attaining development goals (Mehren, 1970)?

The need for biological and economic research aimed at developing a viable livestock production system for the tropics has been noted. There are many unanswered questions relevant to credit and mobilization of capital. Determinants for financing specified development programs and determinants of credit cost and revenue functions are some of these. Also, why do costs and returns differ so greatly among products and functions? What are the requirements for tailoring credit effectively to local conditions (Mehren, 1970)?

Needed demand analysis has likewise been indicated. Further, development programs for livestock and meat industries may be based on consumer requirements if serious deficits exist, but thereafter must rest on estimates of effective demand. It is not yet known

whether increased meat production with higher and more broadly diffused purchasing power is associated with increases or decreases in long-run import demand (9, p. 10). Many other issues in the functional relationship of income change to domestic market attributes are unresolved (Mehren, 1970).

The unanswered questions for production and demand imply similar unknowns for the marketing and distribution system. The evolution of modern food distribution systems in the United States and other developed countries was essentially unplanned. Yet, the various parts of the North American agricultural-industrial system did change in compatible fashion (Mehren, 1970).

Little is known with respect to the relation of the structure and function of government planning to marketing, especially, and perhaps to other sectors. It may not even be feasible or desirable to program the development of marketing segments as some countries have been able to plan and implement production improvements. Flexible and limited experimentation, however, might yield answers and in so doing, avoid the dangers of rigid or spuriously comprehensive systems (Mehren, 1970).

Appendix A

A. Latin American Feed Composition Project

1. Introduction

New developments that have taken place in the field of animal nutrition in recent years have indicated that some systems of feed analysis and methods of computing livestock diets should be modified. Expanded knowledge of feed composition and nutrient requirements of animals have emphasized the importance of adopting more precise methods of balancing animal diets.

In modern nutrient requirement standards, the calorie system is used. This consists of obtaining native values of feeds and stating requirements in terms of digestible, metabolizable and net energy. An improved and systematic nomenclature for feeds has been developed. The system describes the origin and nature of a product which leads to more meaningful analytical data. The system is also adapted to accommodate by-products from the processing of human foods as well as the many crop residues and by-products of feed and foodstuffs.

The Center for Tropical Agriculture and the Department of Animal Science of the Institute of Food and Agricultural Sciences (IFAS) at the University of Florida, with the assistance of a grant from USAID, are working collaboratively with universities, ministries of agriculture and private industries in Latin America and the Caribbean to establish Feed Composition tables for locally produced feeds. This project has been under taken because of the lack of a summarization of analytical and biological data from the area

indicated. It may also serve to standardize the feed analysis procedures, naming of feeds and reporting data.

The objectives of the project are: 1) to collect data which have accumulated on the composition of feeds; 2) to devise a record system which can be used in nutrition laboratories to describe and record chemical and biological data on feeds; 3) to publish feed composition tables.

To accomplish the objectives stated, a brochure of instructions outlines methods of research procedures, data collection and summarization as aids to cope with new developments in animal nutrition.

For the collection of data an international data source form has been divised. The forms are in duplicate and bound in a way which allows collaborating laboratories to have a control file (original copy) of analyses and to provide a duplicate copy of the analysis for the Feed Composition Project at the University of Florida. Upon arrival the information will be put into a data bank and at periodic intervals electronic computer summaries will be completed.

The data from feed composition tables may be used with data from tables of nutrient requirements for the various species of livestock. The form is rather detailed and when a sample of material is recorded, space is included to record: 1) information about the sample; 2) information concerning digestibility trials if conducted on the sample and; 3) data from the chemical and biological analysies of the feed.

The Feed Composition Project has been in progress for a little more than a year. The first several months were, to a large extent, devoted to organizing and staffing the project. A great deal of

time was spent in obtaining facilities, personnel and equipment. Writing and translating instructional material required a large amount of time. In addition, project personnel have traveled extensively throughout Latin America. Twenty four countries and a large number of institutions and personnel within each country have been visited and familarized with the various aspects of the project. Instructional material and data source forms have been distributed to collaborating countries.

During recent months many completed data source forms have been received from Latin American countries. Costa Rica, Brazil, Guatemala, El Salvador, Peru, Mexico, Argentina, Venezuela, Panama, Colombia and Bolivia have contributed significant amounts of feed composition data.

The following section presents a more detailed analysis of the goals and accomplishments of the Feed Composition Project.

2. Preparation of Instructional and other Project Supporting Material

a. The Goals

(1) Manual of Instructions, to give, in detail, procedures of nutritional research, gather feed composition data to be used in preparation of feed composition tables.

(2) Bulletin of Chemical and Biological Methods for Feed Analysis, to be used by researchers for up-dating methods of laboratory feed assay research.

(3) Source forms for Composition of Feeds. A standard form to be used for laboratory records as well as a data retrieval form for reporting feed composition data.

(4) Form Letters. Letters of instruction to supplement the above material to enhance the objectives of the feed composition project.

b. The Accomplishments

(1) Manual of Instructions: a 192 page brochure, titled "Compilation of Data to Prepare Feed Composition Tables for Latin America" was prepared to satisfy the needs of researchers cooperating with the project.

(2) The bulletin of "Chemical and Biological Methods for Feed Analysis" was prepared separately from the manual of instructions. This bulletin of 80 pages contains more than 30 different methods for assaying feed samples. It is intended for the use of researchers studying the composition of feeds.

(3) The "Source Form for Composition of Feeds" was prepared and contains space to record sample identification information, an international name and reference number, biological, moisture, proximate analysis, organic matter energy, mineral, vitamins, and amino acid assay data.

(4) Form Letters. Several form letters written to explain procedures or other aspects of the project have been prepared and sent to the appropriate people. The above materials were written in English and then translated into Spanish and Portuguese. For more detail regarding the above material refer to them by the quoted title. For actual numbers distributed and on-hand refer to the Inventory Section of this report.

3. Distribution of Instructional and other Project Supporting Material

a. The Goals:

(1) To put the material into the hands of people conducting analytical research on feeds common to Latin America.

(2) As to time, a sizeable portion of the material was to be delivered during the year of 1970.

b. The Accomplishments:

(1) Educational Institutions. More than 50 different colleges or universities, in Latin America, have received part or all of the project instructional material. Several persons within many of the institutions have received the material.

(2) Federal or State Organizations. Of the 24 collaborating countries, nearly all federal research agencies and many of the state agencies have received the instructional material.

(3) Feed Manufacturers. From about a dozen of the large companies in Latin America nearly all have received material. Others will receive instructional material in the near future.

4. Retrieval of Composition Data and Other Scientific Literature

a. The Goals:

(1) Composition Data. The goal for the year 1970 was to receive adequate analytical data to prepare the first trial or example feed composition tables for Latin America, early in 1971.

(2) Other scientific Data. To organize a system of literature retrieval and receive adequate literature to test the system of retrieval and filing.

b. The Accomplishments:

(1) Composition Data. Presently, data has been received from more than 10 different countries. From more than 8000 samples analyses received, about 600 different feeds are represented.

Adequate data are presently available for a print-out and preparation of composition tables.

(2) Other Scientific Literature. All collaborating countries have been contacted and given instructions regarding sending Animal Science research literature.

The summary given below shows the number of individual bulletins or other forms of literature actually received at the University of Florida Feed Composition Laboratory:

Country	Animal Science Publications	Feed Composition Analyses
Argentina	53	350
Bolivia	19	230
Brazil	250	1000
Chile	39	---
Colombia	65	300
Costa Rica	43	3000
Ecuador	36	300
Guatemala	48	450
Honduras	20	---
Jamaica	19	---
Mexico	47	650
Nicaragua	12	200
Panama	34	500
Peru	43	700
Puerto Rico	48	---

Country	Animal Science Publications	Feed Composition Analyses
Trinidad	41	---
Venezuela	28	500
Total	845	8180

5. Countries Visited and People Contacted

a. The Goals:

(1) Personal Visits. The objective was to visit as many countries and contact as many key individuals within the countries as possible during 1970 and 1971.

(2) Explanation of Project. When countries were visited, seminars, discussions and other types of communication interchanges were conducted in order to help the co-operating people understand the project and the mutual benefit which would result by its successful completion.

(3) Correspondence communication. Following country visits, subsequent correspondence was sent for follow-up or clarification purposes. Correspondence contact was also used to contact people when unavailable during country visits.

b. The Accomplishments:

(1) Personal Visits. The project leader and other University of Florida animal and dairy science faculty have visited all co-operating countries. Dr. Lorin Harris from Utah State University (consultant to the project) visited Argentina, Brazil, Colombia, Costa Rica and Mexico. More than 300 individual people in Latin America have been contacted by way of a personal

visit.

(2) Explanation of Project. During the visits, by way of seminar or other methods, the project goals and anticipated results were presented and discussed. The approach of the project being mutually beneficial was stressed.

(3) Correspondence Communication. Whenever co-operation was initiated, follow up letters of explanation or other problem solving situations were sent to the involved people. More than 400 different people have been reached by correspondence concerning the Feed Composition Project.

6. Summarization of Retrieval Data

a. The Goals:

(1) Combinable and summarizable with NRC United States - Canada feed composition data.

(2) Compilation to prepare feed composition tables.

(3) Provide each co-operating laboratory with a summary print-out of their contributed composition data.

(4) Nomenclature and identification standardization

b. The Accomplishments:

(1) Codes, computer programs, prediction formulas and format have been developed which provide potential system for combining or dove-tailing NRC composition data with Latin American feed data. Being able to combine data will provide and add to the value of the project in several ways. For example, much Latin American data lacks biological studies such as digestibility which provides net energy, productive energy and maintenance energy estimates. Using NRC biological

data, with the appropriate formulas, will enable estimating their values. Using the data will also provide depth in terms of statistical confidence.

(2) Data is being summarized to prepare composition tables which will show more than 20 constituents about each feed as well as the coefficient or variability.

(3) The data is coded such that a complete summary of the data given by each laboratory can be drawn from the computed summarization system.

(4) Feeds are being named according to the NRC system. The feed is also given a reference number. The international name and number will provide positive identification and serve to reduce variability from inaccurately identifying feed types.

7. Inventory of Instructional Material

a. Total Number Printed:

(1) Brochure (Manual of Instruction)

900 books (192 pages per book)

Languages Printed in:

English = 300
Spanish = 400
Portuguese = 200

(2) Source Forms

500 books (200 pages per book)

Languages Printed in:

English = 100
Spanish = 400
Portuguese = 100

(3) Technical Manual

500 books (80 pages per book)

English = 100
Spanish = 300
Portuguese = 100

b. Distribution of Instructional Materal

Country	Brochure	Source Form Books
1) Argentina	25	19
2) Bolivia	8	3
3) Brazil	15	25
4) Chile	4	4
5) Colombia	18	12
6) Costa Rica	10	22
7) Cuba	--	--
8) Dominican Republic	11	7
9) Ecuador	8	2
10) El Salvador	12	8
11) French Guiana	--	--
12) Guatemala	12	10
13) Guyana	4	1
14) Haiti	--	--
15) Honduras	10	5
16) Jamaica	4	2
17) Mexico	15	10
18) Nicaragua	8	4
19) Panama	16	8
20) Paraguay	8	4
21) Peru	15	10
22) Puerto Rico	8	3

Country	Brochures	Source Form Books
23) Surinam	--	--
24) Trinidad	8	6
25) Uruguay	4	4
26) Venezuela	25	6
27) USAID/Wash. D.C.	165	2
28) Feed Manufacturers	30	15
29) Feed Composition lab	10	5
30) Misc. distribution	50	20

8. Facilities

Physical facilities being used for the furtherance of the project are given: Officer = 7, store room = 1. Includes all desks, cabinets, machines and material associated with a typical functioning project.

9. Personnel

The following positions are presently staffed and working full time in the Feed Composition Project:

(1) Project Leader. Nutritionist

(2) Assistant to the Project Leader. Nutritionist = M.S.

(3) Clerk Typist/lab technician

(4) Clerk Typist/secretary

(5) Graduate assistant

10 Study Visit to Utah State University

During October and November, 1970, 4 weeks were spent by the project leader, in Logan, Utah working with Dr. Lorin Harris. The assistant to the project leader was also there during that 4 week

period. Systems were developed to code, name, reference number, develop new name file and programs for computer summarization. About 1500 filled-in source forms (from Costa Rica) were used in developing the above listed systems. The procedures used were actually worked with in order to serve as examples which would help in understanding of data summarization phase of the project.

11. Recommendations

a. Continuation of the project - committments have been made to 24 collaborating Latin American countries, involving more than 300 animal and forage plant scientists.

b. Continued working relationship with the NRC feed composition project - to maintain coordinated coding and computer programming which will enable complimentary use of data from different continents.

c. Increase the number of staff positions working in the project to enable an adequate work force for data retrieval, summarization, distribution and application of feed composition data.

d. Engage 10 to 15 persons (nutritionists) actually living in Latin America to work for the project (10 to 30 days each per year) - to help establish a feeling among Latin Americans that the project does indeed have their best interests as inherent project objectives.

e. Encourage the development of an International Feed Composition Project - the realization of an International system which would lead to a world encyclopedia of feed nomenclature and composition data, would be a significant contribution to world agriculture.

12. Extending Livestock Feed Composition Project

As indicated in the "Progress Report" prepared in December, 1970, the project has completed nearly all requirements to set composition data gathering and summarization in full progress. It should be emphasized that, at least, three additional years are needed to accomplish the prime objectives of the project. The following outline presents an estimation of feasible accomplishments as related to time within two years. (Presented at 12 month intervals).

Refer to the attached time table

** Project status is presented in terms of percent of fully completed objectives. It must be emphasized that many phases of this type of project cannot realistically be carried to a 100% completion. It is also important to point out that a great deal of good can result prior to objectives being fully completed.

** Phases of the project which should continue beyond the dates indicated are: 1) continued data composition summarization, 2) Revised composition table construction from new data, 3) Redistribution of revised composition tables, 4) Extensive project to implement feed composition table application.

PROJECT PROGRESS TIME TABLE

Present and Predicted Project Status**	June 1970	June 1971	June 1972	June 1973	June 1974
1- Countries and personnel visited: Need = 200-300%	50%	100%	175%	250%	275%
2- Writings, translations, and printing material: Need = 100%	25%	75%	90%	95%	100%
3- Distribution of source forms and other instructional material: Need = 95-100%	NONE	50%	90%	95%	100%
4- Feed analytical data received: Need = 90-100%	NONE	10%	50%	75%	95%
5- Summarization procedures completed: Need = 90-100%	NONE	50%	75%	90%	100%
6- International feed names and numbers assigned: Need = 90-100%	NONE	10%	75%	90%	100%
7- Feed analytical data summarization: Need = 90-100%	NONE	10%	50%	75%	95%
8- Computer print-outs completed: Need = 90-100%	NONE	25%	50%	75%	95%
9- Preliminary composition tables constructed: Need = 90-100%	NONE	25%	75%	90%	95%
10- Final composition tables completed: Need = 90-100%	NONE	NONE	50%	75%	95%
11- Distribution of composition tables: Need = 90-100%	NONE	NONE	50%	75%	95%
12- Latin American application of composition tables: Need = 25-50%	NONE	NONE	15%	25%	50%

** Refer to preceding page

Appendix B

B. IFAS INSTITUTIONAL FACILITIES AND CAPABILITIES

The Institute of Food and Agricultural Sciences (IFAS) was established in 1964 through consolidation of the College of Agriculture, School of Forestry, Agricultural Experiment Stations and Cooperative Extension Service. The units were combined to promote interdisciplinary efforts in teaching, research and extension. Reorganization facilitated development of programs which cut across boundaries of the conventional administrative unit -- the department.

A major reorganization of research was conducted at the time IFAS was established, to develop interdisciplinary teams. The teams involve personnel from many different departments, encouraging cooperation with others having similar training and interests, including participation in research projects, seminars, and graduate training programs in the basic disciplines. All 18 departments within IFAS will be available to support the proposed program for strengthening capabilities for applied research, training, consultation and services in animal production in the tropics.

Given the long-standing geographical, economic and cultural ties of Florida to Latin America it has only been natural that IFAS would recognize and respond to the unique ability to be of assistance to this area especially in seeking to increase agricultural production. University of Florida participation in tropical agriculture has spanned many years and in 1965 the administration acted to create

a Center for Tropical Agriculture (CTA). CTA is a coordinating body for the research, instruction and extension sections of the Institute in matters related to tropical agriculture. It has access to the entire IFAS professional staff, consisting of approximately 800 technical personnel.

CTA normally awards 12 to 15 assistantships each year for students to conduct research in Latin America. A large and continuing group of students from several tropical countries have been and are now enrolled in the various departments of IFAS at both the undergraduate and graduate levels. These graduates, especially those with advanced degrees, serve as very useful contacts and collaborators for further research in the various countries.

At the present the Institute has activities in all of the Latin American countries through an AID grant to obtain feed composition data on locally produced feeds. Eight staff members have been involved in country visits to contact local technicians concerning the goals of the project. In addition, many of the staff from the Departments of Animal Science, Dairy Science, Soils, Agronomy and Agricultural Economics have participated in the planning of materials being utilized in the program.

Another project which is providing supplemental information which will expand the effectiveness of the AID Feed Composition Project is being financed by the Ford Foundation. The purpose of this program is to study systems for production of cattle in the savannahs of tropical Latin America in order to determine the economics of investment at various levels of production. Data have been

collected from 27 ranches in the "llanos" of Venezuela and are available from 44 additional ranches through an FAO project. The data are being analyzed and will be available early in 1971.

Other projects with livestock production inputs are now underway or will be initiated in 1971 in El Salvador, Nicaragua, Honduras, Jamaica, Costa Rica, Venezuela, Ecuador, Guyana and Viet Nam. The program in Guyana is typical of the multidisciplinary approach to problem solving. The specific objective is to assist the government of Guyana to establish a livestock and crop experiment station in the intermediate savannahs. Research and management programs are established through short-term visits of University of Florida staff to consult with Guyanese technicians at the station. Coordination of University of Florida inputs is achieved through the CTA with a professor of Agronomy serving as project leader. Contributing departments to the program include Animal Science, Agronomy, Agricultural Economics, Agricultural Engineering, Fruit Crops and Vegetable Crops. The USAID Mission to Guyana, the Guyanese government and the University of Florida are cooperating to achieve significant progress in meeting project goals.

Another innovative technique is being utilized to expand research in livestock and forage production. As previously mentioned the University of Florida has a large number of graduates from tropical countries at the B. S., M. S. and Ph. D. level who are now working in their respective countries in teaching, research and production. Collaborative research projects have been established with a number of these individuals whereby a portion of the project is the respon-

sibility of a University of Florida staff member in Gainesville and another part or in some cases a duplication of the same work is done by a collaborator in the tropical country. Continual contact and communication is realized by periodic visits of the tropical livestock program leader and/or the collaborating participants to the project sites. Financing of the research at each site is the responsibility of the resident scientists with local funds and with minimum contributions from the University of Florida to fill specific needs. All work is summarized and published jointly by the collaborating scientists.

Other activities of CTA which have contributed to agricultural development in Latin America have been the publication of books, mimeographs, bulletins, etc., with specific reference to the tropics and the annual short courses held in various fields of interest. Two of the most significant of these have been the Beef Cattle Short Course and the Latin American Livestock and Poultry Conference. The former normally attracts approximately 800 to 900 participants with about 10 percent being from Latin America. The Latin American Livestock and Poultry Conference which is given in Spanish, annually attracts over 100 Latin Americans representing up to 19 different countries.

As a result of these programs, the tropical agricultural program --especially in livestock production and related specialities-- has grown at a very rapid pace at the University of Florida. Almost daily, requests for information on tropical livestock production arrive from producers in the various countries as well as from U.S. producers in developing livestock enterprises in tropical countries.

RELATED PROJECTS IN PROGRESS

Research projects have been developed and are being carried out in the following areas:

A. Management of Cows and Calves (1) (2)*

B. Mineral Supplementation (1)

C. Energy Supplementation and Protein and Non-Protein Nitrogen Additives - Dry and Wet Season (2) (3)

D. Unimproved Pasture Management (4) (7)

E. Improved Pasture for Dry Season Forage (4) (5) (6) (7)

F. Conservation of Forage for Dry Season (4) (5)

G. Regional and Economic Studies (4) (7) (8) (9) (10)

H. Genetic Potential of Crossbred Animals (11) (12)

I. Compilation of Feed Composition Data and Research Information From the Latin America Tropics (13)

1. Title: Determination of Mineral Composition of Livestock Feeds in Venezuela.

Location: Central University and Ministry of Agriculture, Maracay, Venezuela.

Objectives: To gather existing data on feed composition and conduct analyses where data is incomplete and publish the information obtained in a usable form. Survey liver and blood composition of cattle from contrasting environmental regions of Venezuela. Conduct mineral balance trials on cattle using common feedstuffs.

Investigators: Ray Shirley, Claudio Chicco, Jose Perdomo.

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*Numbers in parentheses refer to the research projects which follow.

2. Title: Nutritive Supplementation of Tropical and Subtropical Forages for Cattle.

Location: Ministry of Agriculture, Maracay, Venezuela

Objective: To develop feeding supplements and supplementation programs which will improve the performance of cattle grazing tropical and subtropical forages during the periods when they provide inadequate nutrient intake.

Investigators: C. B. Ammerman and C. Chicco.

3. Title: Nutritive Evaluation of Tropical and Subtrop Forages.

Locations: Central University of Venezuela, Maracay Venezuela and in Florida.

Objective: To determine the voluntary intake and nu digestibility of various tropical and subtropical forages har or grazed under various conditions in Florida and the tropics refine laboratory methods for estimating forage nutritive value.

Investigators: J. E. Moore, G. O. Mott, C. Chicco

4. Title: Evaluation of Alternative Cattle-Forage-Concentrate Systems in the Wet/Dry Tropics.

Location: Four sites in Venezuela--one dry, one wet and two wet-dry.

Objective: To evaluate the productive capacity of several pasture-cattle management systems of low, intermediate and high levels of intensity from a technical and economic point of view.

Investigators: G. O. Mott, B. R. Eddleman, D. H. Timm (graduate student)

5. Title: Pasture Feeding Trial.

Location: Ministry of Agriculture Experiment Station, Calabozo, Venezuela.

Objective: To determine the effect of supplemental jaragua forage and molasses feeding upon the performance of steers during a 12-month period including one dry season. To determine the amount of supplemental feed required in the various systems and estimate the cost of providing supplemental feed and the returns to be expected.

Investigators: G. O. Mott and C. Chicco.

6. Title: Effect of Lime, Potassium and Environmental Factors on the Phosphorus Nutrition of Tropical Legumes.

Location: Lake Izabal, Guatemala.

Objective: To provide some of the basic information that will be needed to develop leguminous forages for livestock in the tropics.

Investigator: V. M. Urrutia (graduate student)

7. Title: Minimum Resource Requirements for Specified Levels of Income on Crops-Livestock Farms in the Sinu Valley, Department of Cordoba, Colombia.

Location: Colombian Agrarian Reform Institute, Monteria, Colombia.

Objective: Determine the nature of enterprise organization and the magnitude of resource levels needed to obtain specified income levels to crops-livestock farms in the Sinu Valley of Colombia.

Factors to be considered include farm product prices, capital availability and cost, land quality and managerial ability of the farm operator.

Investigators: B. R. Eddleman, N. L. Meyer (graduate student)

8. Title: Pasture Grazing Trials

Objective: Two trials are to be conducted at Carrasquero and El Guayabo, state of Zulia, Venezuela. At Carrasquero the pastures being studied are Elephant Grass, Guinea and Para. At El Guayabo, Guinea, Para and Alema will be included in the test.

Investigators: D. H. Timm, G. O. Mott, J. C. Glenn, Euro Rimcon, and C. F. Chicco.

9. Title: An analysis of marketing services and regions for beef cattle in Quesada and Liberia, Costa Rica.

Location: Cantons of Quesada and Liberia, Costa Rica.

Objective: To compare the evolution of beef cattle marketing and related systems in two culturally and environmentally different regions of Costa Rica. Quesada is a new ranching area in the humid tropics populated by recently immigrated settlers from the highlands and Liberia is a wet/dry tropical area with a long history of cattle raising.

Investigator: V. Smith (graduate student)

10. Title: The Beef Industry of Roraima Territory, Brazil.

Location: The Roraima savannas of Brazil's northern frontier zone.

Objective: To assess the present state of the beef cattle industry in the Roraima savannas; numbers of cattle, production, quality, limiting factors and marketing systems.

Investigator: T. F. Kelsey

11. Title: Breeding and Management Systems for Beef Production in Central America.

Location: Pan American Agricultural School, Zamorano, Honduras.

Objective: To compare the fertility rate, pre-weaning growth, postweaning growth and carcass characteristics of various breed groups, including Brahman-European crosses.

Investigators: M. Koger, D. A. Franke, J. C. Glenn, Ing. Candellaro Rios.

12. Title: Management and Reproductive Performance of Brahman and Brahman Crossbred Cattle.

Location: Ministry of Agriculture Experiment Station, Calabozo, Venezuela

Objective: To determine the best crossbreeding system for the tropics of Venezuela using pure-bred and Criollo stock currently available locally, and to obtain data on production levels with various systems of management.

Investigators: M. Koger, Dieter Plasse and Tiburcio Linares.

13. Title: Feed Composition Studies in Latin America.

Location: All countries of Latin America under the coordination of the University of Florida.

Objective: To compile chemical and biological analysis of Latin American produced livestock feeds. Coding and computer storage of data will be carried out to facilitate summarization for publication of tables.

Investigators: W. C. Christiansen, Staff of Departments of Animal, Dairy and Poultry Science of the Institute of Food and Agricultural Sciences of the University of Florida. Personnel of nutrition laboratories of colleges of agriculture, universities and private feed companies in Latin America.

NAME	SPECIALIZATION	COUNTRY OF INTERNATIONAL EXPERIENCE	EDUCATION AND PROFESSIONAL EXPERIENCE
C. B. Ammerman	Ruminant Nutrition	Colombia, Guyana Venezuela, Panama	Univ. of Kentucky, 1951, B.S.; 1952, M.S. Univ. of Illinois, 1956, Ph.D. U. S. Army Med. Res. Institute, 1956-58 University of Florida, Professor, 1958-
F. W. Bazer	Animal Physiology	El Salvador	Centenary Col. of La, 1960, B.S. La. State University, 1963, M. S. N. C. State, 1968, Ph.D. Univ. of Florida, Asst. Prof. 1968-
J. E. Bertrand	Animal Nutrition	El Salvador	Southwestern La. Inst., 1948, B. S. Louisiana State, 1952, M. S.; 1960, Ph.D. Arkansas State Col., Asst. Prof., 1956-58 Univ. of Florida, Assoc. Prof., 1966-
W. G. Blue	Plant Nutrition	Costa Rica, Guyana, British Honduras, Venezuela, Australia	Univ. of Mo., 1947, B. S.; 1948, M. S.; 1950, Ph. D. Univ. of Florida, Asst. Prof., 1950-56 Univ. of Florida, Assoc. Prof., 1956-63 Univ. of Florida, Professor, 1963-
R. E. Bradley	Tropical Diseases	Colombia Venezuela	Fla. State, 1949, B. S. Univ. of Ga., 1953, M. S.; 1954, D. V. M.; 1965, Ph.D. Univ. of Fla., Asst. Prof., 1965-69 Univ. of Florida, Assoc. Prof., 1969-
J. W. Carpenter	Livestock Production Meat Technology	Viet Nam	Univ. of Kentucky, 1952, B. S.; 1953, M. S Univ. of Florida, 1959, Ph. D. Univ. of Florida, Asst. Prof., 1959-65 Univ. of Florida, Assoc. Prof., 1965-

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H. L. Chapman	Ruminant Nutrition	Nicaragua, Costa Rica	Univ. of Fla., 1948, B. S; 1951, M. S. Iowa State, 1955, Ph. D. Univ. of Florida, Asst. Prof., 1951-53 Iowa State, Industrial Fellow, 1953-55 Univ. of Florida, Asst. Prof., 1957-63 Univ. of Florida, Prof., 1963-65 Univ. of Florida, Prof. & Head, 1965-
W. C. Christiansen	Ruminant Nutrition	Uruguay, Brazil, Nicaragua, Costa Rica Argentina, Mexico Paraguay, Bolivia Honduras, Panama Colombia	Utah State, 1958, B. S. Iowa State, 1962, Ph. D. Iowa State, Res. Assoc., 1961-63 Iowa State, Asst. Prof., 1963-65 Snow Col. Utah, Assoc. & Chairman, 1965-70 Univ. of Florida, Assoc, Prof., 1970-
G. E. Combs	Swine Management and Nutrition	Venezuela, El Salvador	Univ. of Florida, 1951, B. S.; 1953, M. S. Iowa State, 1955, Ph. D. Univ. of Florida, Asst. Prof., 1955-62 Univ. of Florida, Assoc. Prof., 1962-67 Univ. of Florida, Professor, 1967-
T. J. Cunha	Animal Nutrition	Latin America, Australia, Asia	Utah State, 1940, B. S.; 1941, M. S. Univ. of Wisconsin, 1944, Ph. D. Washington State Col., Instructor, 1944-45 Wash. State Col., Asst. Prof., 1945-46 Wash. State Col., Assoc. Prof., 1946-48 Univ. of Florida, Assoc. Prof., 1948-50 Univ. of Florida, Prof. & Chrm., 1950-
J. K. Dow	Agricultural Economics	Colombia, Guyana Venezuela, Ecuador	Univ. of Illinois 1961, B. S. Univ. of Mo., 1966, M. S.; 1970, Ph. D. Univ. of Fla., Asst. Prof., 1968-

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B. R. Eddleman	Agricultural Economics	Venezuela, Colombia, Guyana	Texas Tech., 1959, B. S. North Carolina State, 1962,M.S.; 1966, Ph.D. Texas A & M., Asst. Prof., 1964-66 Univ. of Florida, Asst. Prof., 1966-69 Univ. of Florida, Assoc. Prof., 1969-
G. T. Edds	Tropical Diseases	Venezuela Colombia, Viet Nam	Texas A & M, 1936, B. S. & D. V. M., 1938, M. S. Univ. of Minn., 1952, Ph. D. Texas A&M, Instructor to Prof., 1936-50 Univ. of Florida, Prof. Chrm., 1962-
D. E. Franke	Animal Breeding	Guyana	Stephen F. Austin St. Col., 1960, B. S. La. State College, 1965, M. S. Texas A&M, 1968, Ph. D. Univ. of Florida, Asst. Prof., 1968-
J. C. Glenn	Animal Physiology and Management	Ethiopia, Venezuela Costa Rica, Ecuador Nicaragua, Panama Guyana, El Salvador Brazil, Honduras Viet Nam	Auburn Univ., 1953, B. S. Mississippi State, 1954, M. S. Oklahoma State, 1959, Ph. D. Midwestern Univ., Inst., 1955-57 Haile Selassie I Univ., Asst. Prof., 1959-61 La. State, Asst. Prof., 1961-66 Universidad de Oriente, Tech. Advisor,1966 - 68 Univ. of Florida, Assoc. Prof., 1968

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R. H. Harms	Poultry Nutrition	El Salvador, Viet Nam	Univ. of Arkansas, 1953, B.S.; 1954, M.S. Texas A&M, 1956, Ph. D. Univ. of Tennessee, Asst. Prof., 1955-57 Univ. of Tennessee, Assoc. Prof., 1957-62 Univ. of Florida, Professor, 1962-63 Univ. of Florida, Prof. & Chrm., 1963-
J. F. Hentges	Ruminant Nutrition	Costa Rica	Oklahoma A&M, 1948, B.S. Univ. of Wis., 1950, M.S.; 1952, Ph. D. Univ. of Florida, Asst. Prof., 1952-56 Univ. of Florida, Assoc. Prof., 1956-66 Univ. of Florida, Prof., 1966-
M. W. Koger	Beef Cattle Breeding	Venezuela, Guyana Honduras	New Mexico St. Univ., 1939, B. S. Kansas State, 1940, M. S. Univ. of Missouri, 1943, Ph. D. Univ. of Florida, Professor, 1951-
A. E. Kretschmer Jr.	Tropical Legumes	Costa Rica Australia	Univ. of Florida, 1949, B. S. Rutgers Univ., 1952, Ph. D. Univ. of Florida, Asst. Prof., 1952-58 Univ. of Florida, Assoc. Prof., 1958-66 Univ. of Florida, Prof., 1966-
W. A. Krienke	Dairy Technology	Costa Rica El Salvador	Oklahoma St. 1932, B. S.; 1940, M. S. Oklahoma St., Inst., 1940-42 Oklahoma St., Asst. Prof., 1942-45 Univ. of Ill., Asst. Dairy Tech., 1945-47 Univ. of Fla., Assoc. Prof., 1947-

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J. E. McCaleb	Forages	El Salvador, Nicaragua	Ag. & Mech. Col. of Texas, 1941, B.S., 1951, M.S. Ag. & Mech. Col. of Texas, 1954, Ph. D. Texas Tech. Col., Asst. Prof., 1953-54 Midwestern Univ., Asst. Prof., 1954-55 Univ. of Florida, Asst. Prof., 1955-63 Univ. of Florida, Assoc. Prof., 1963-
D. E. McCloud	Forages	Costa Rica, Guyana Venezuela, Viet Nam Australia	Purdue, 1945, B.S.; 1947, M. S.; 1949, Ph. D. Univ. of Florida, Asst. Prof., 1948-54 Univ. of Florida, Assoc. Prof., 1954-57 USDA, 1957-65 Univ. of Florida, Prof. & Chrm., 1965-
J. E. Moore	Forage Utilization Ruminant Nutrition	Trinidad, Puerto Rico Venezuela, Guyana Dominican Republic Australia, Costa Rica	Ohio State, 1957, B.S.; 1959, M. S.; 1961, Ph. D. Univ. of Florida, Asst. Prof., 1961-66 Univ of Florida, Assoc. Prof., 1966-
A. Z. Palmer	Nutrition Technology Meat Quality and Grading Systems	Jamaica, Venezuela	Oklahoma State, 1947, B. S. Univ. of Missouri, 1952, Ph. D. Univ. of Florida, Assoc. Prof., 1955-64 Univ. of Florida, Prof., 1964-
R. L. Shirley	Ruminant Nutrition	Jamaica, Guatemala Australia	Univ. of W. Va., 1937, B.S.; 1939, M. S. Michigan State, 1949, Ph. D. Michigan State, Asst. Prof., 1947-49 Univ. of Florida, Professor, 1949-

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W. W. Thatcher	Animal Physiology	El Salvador	Univ. of Md., 1963, B. S.; 1965, M. S. Michigan State, 1968, Ph. D. Michigan State, Res. Inst., 1967-68 Univ. of Florida, Asst. Prof., 1969-
H. D. Wallace	Swine Nutrition	Salvador, Venezuela	Univ. of Ill., 1945, B. S.; 1947, M. S. Cornell, 1950, Ph. D. Univ. of Florida, Asst. Prof., 1951-53 Univ. of Florida, Assoc. Prof., 1953-61 Univ. of Florida, Professor, 1961-
A. C. Warnick	Animal Physiology	Argentina, Venezuela	Utah State, 1942, B. S. Univ. of Wis., 1947, M. S.; 1950, Ph. D. Univ. of Florida, Asst. Prof., 1953-56 Univ. of Florida, Assoc, Prof., 1956-63 Univ. of Florida, Prof., 1963-
C. J. Wilcox	Dairy Cattle Breeding	Ecuador, Colombia Venezuela El Salvador	Univ. of Vermont, 1950, B. S. Rutgers, 1955, M. S.; 1959, Ph. D. Univ. of Florida, Asst. Prof., 1959-65 Univ. of Florida, Assoc. Prof., 1965-
J. M. Wing	Dairy Cattle Management	Colombia El Salvador	Berea (Ky.), 1946, B. S. Colorado State, 1948, M. S. Iowa State, 1952, Ph. D. Univ. of Florida, Asst. Prof., 1951-60 Univ. of Florida, Assoc. Prof.,1960-66 Univ. of Florida, Prof., 1966-

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